Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

DECEMBER, 1957

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TECHNOLOGY DEPT.

Automatic ELBOLIFT goes to work at Continental Can Company

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DETROIT

First of the new Revolutionary Elbolifts to go into service at one of Continental Can Company's Chicago Plants. It was "made to order" for Continental's new streamlined method of making cans from coil stock. The Elbolift unloads 15000 lb. coils from boxcars...handling them in and out of storage...to the coil upender illustrated above. The unique advantage of the Elbolift is that the 15000 lb. model weighs 6000 lbs. less than any mast type truck of comparable capacity and maneuvers easily in and out of boxcars. Capacities 12000 to 20000 lbs. Write for illustrated folder.

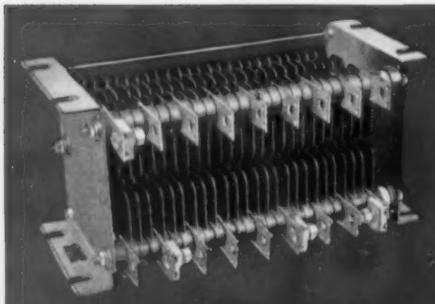
Automatic
Electric Industrial Trucks

AUTOMATIC TRANSPORTATION COMPANY
Division of The Yale & Towne Manufacturing Company
Dept. X-7, 47 West 87th Street, Chicago 20, Illinois
WORLD'S LARGEST EXCLUSIVE BUILDER OF ELECTRIC-DRIVEN INDUSTRIAL TRUCKS

When you need MILL DUTY RESISTORS

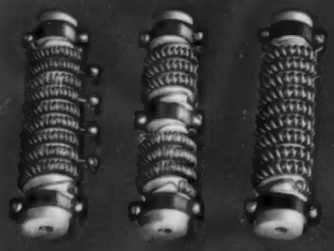
insist on the finest . . .

insist on Cutler-Hammer



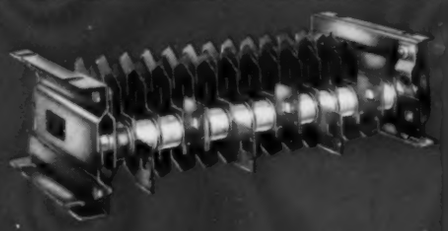
CAST GRID RESISTORS

Cutler-Hammer Bulletin 11010 Cast Grid Resistors are built to take it. Their extra rugged construction makes them ideal for those tough applications where severe overloads are to be expected. The individual cast grids are supported at three points within the sturdy steel frame and thoroughly insulated with mica tubes and washers. All grid terminals are easily accessible.



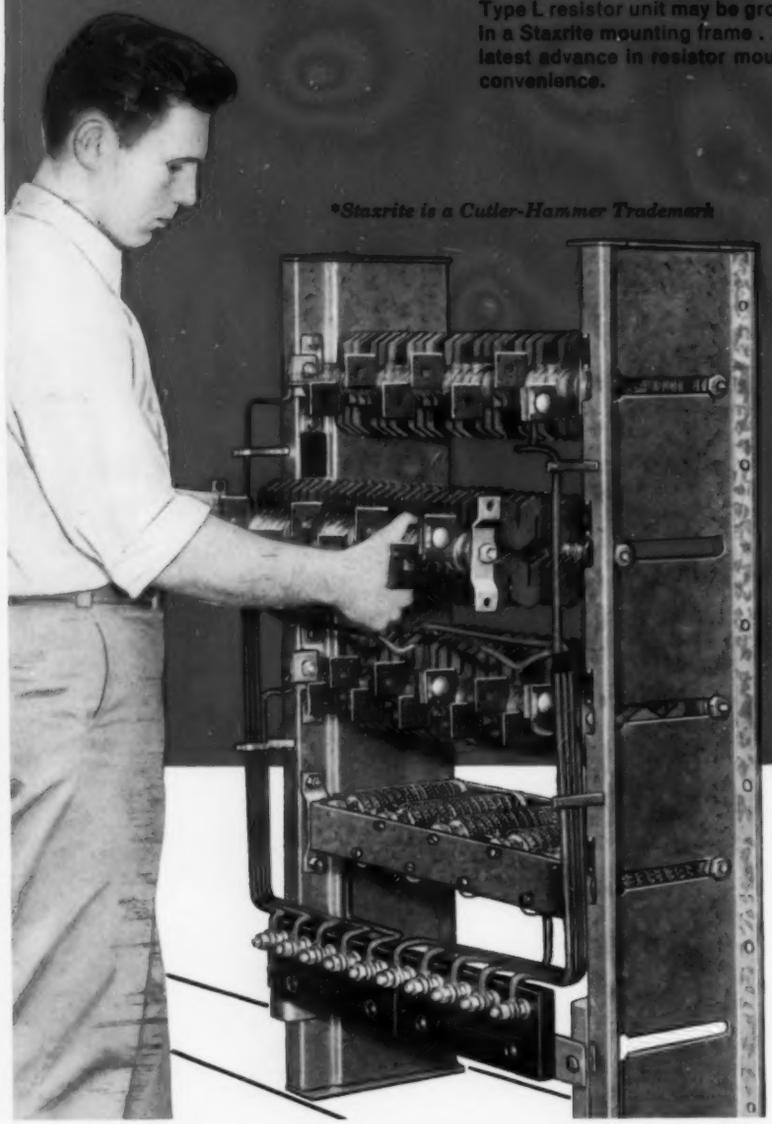
UNIT TYPE RESISTORS

These Bulletin 11003 Type L Resistors are available in a wide range of resistance values and capacities for either A-c or D-c service . . . perfect for scores of applications requiring a light weight, compact resistor element. Cutler-Hammer Type L resistors may be mounted separately or grouped in any of four standard size resistor frames. Note, multiple Type L resistor unit may be grouped in a Staxrite mounting frame . . . the latest advance in resistor mounting convenience.



NON-BREAKABLE RESISTORS

Cutler-Hammer's Bulletin 11011 Non-breakable Resistor with exclusive "draw-out" design is the choice among mill engineers everywhere. Grids are stamped from a chromium steel alloy and then welded together forming a continuous current path with a stabilized resistance value. These resistors are shock-proof, vibration-proof, and corrosion-resistant. Their high thermal capacity makes them ideal for severe mill and crane applications. And the "draw-out" design is extra value at no extra cost. All units slide in and out easily and quickly without disturbing the end frames, adjacent resistor units, or mounting members. "Draw-out" design will save you time and expense during installation, maintenance, and alterations.



*Staxrite is a Cutler-Hammer Trademark

**Staxrite*—Here is the most modern and efficient means of mounting multiple resistor units . . . a Cutler-Hammer "first", a Cutler-Hammer exclusive. These units are free-standing and only require the floor area of a single resistor box, but they can accommodate up to nine resistor frames in a single unit. The Staxrite mounting frame packs more resistor material in a given space than ever before, and yet every resistor unit is easily reached and serviced because of the "draw-out" design. Complete terminal board wired assemblies practically eliminate costly on-the-job wiring. Unwired assemblies also available. The Staxrite mounting frame will handle the Type L resistor frame, the non-breakable resistor frame or a combination of both. Save time, save space, save money with Staxrite.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Write today for further data on mill duty resistors and the Staxrite mounting frame. CUTLER-HAMMER Inc., 1269 St. Paul Avenue, Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers at 20th and Northampton Sts., Easton, Pa. Editorial and advertising offices, 1010 Empire Bldg., Pittsburgh 22, Pa. Entered as second class matter at Easton, Pa.

Aetna-Standard Stretch Reducing Mill built for The Colorado Fuel & Iron Corporation, Pueblo, Colorado.

STRETCH REDUCING - tonnage producer

Stretch Reducing makes existing Seamless Tube Mills more productive!

For Example: To make a given number of tubes in small sizes by Stretch Reducing requires only one-fourth the number of billets.

The billets are larger and therefore easier to handle on a mill designed to produce larger O.D.'s.

Because of the decrease in number of billets required to produce a specific footage of tubing, 50% to 75% of the time previously required for the production of tubing can be scheduled for the production of larger and heavier pipe sections.

How much additional equipment is needed? What are the costs? What will be the yield? How much will be saved in costs? Those and many other questions can be answered by Aetna-Standard who have built and are building most of the Stretch Reducing Mills.

AETNA • STANDARD

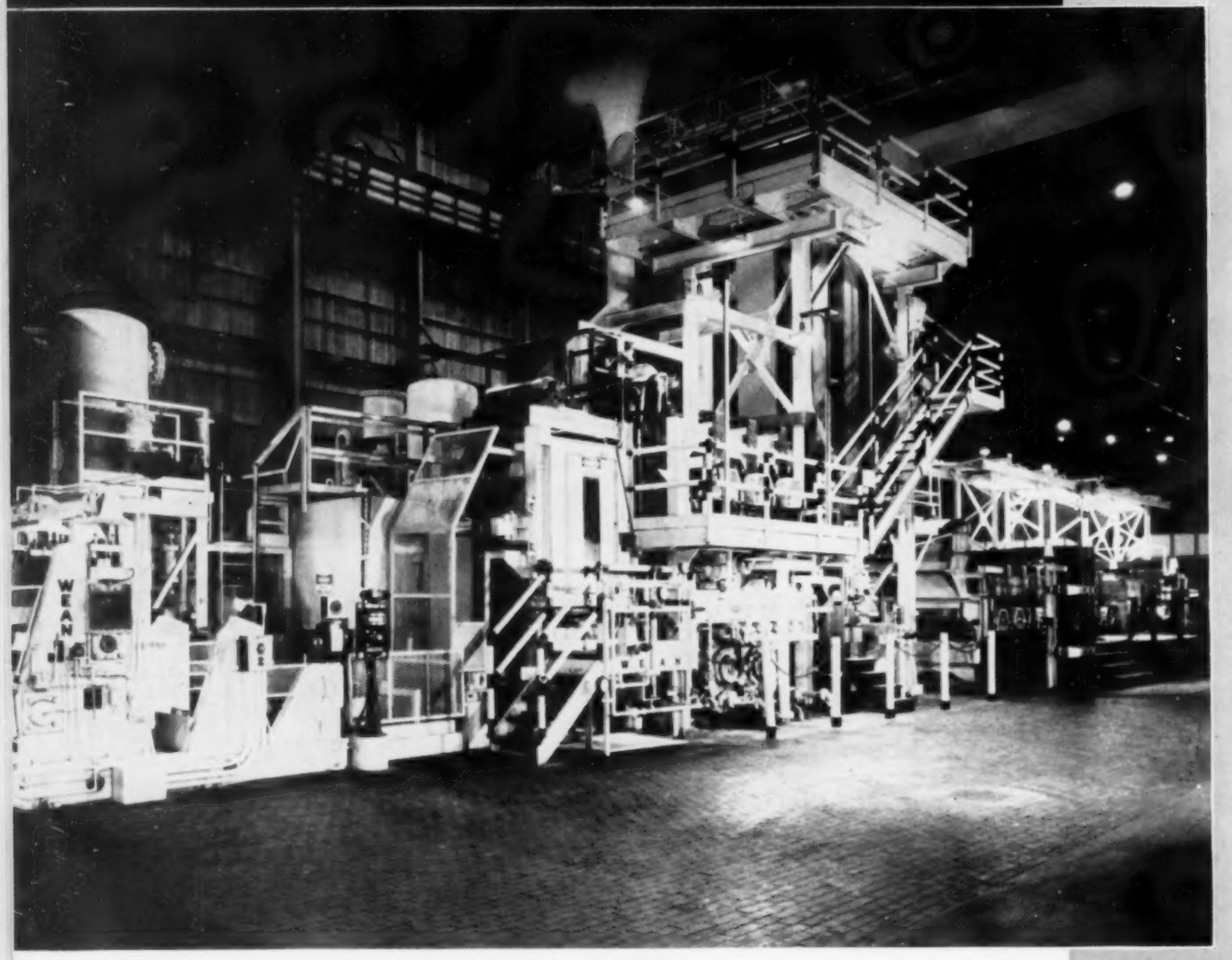
THE AETNA-STANDARD ENGINEERING COMPANY

GENERAL OFFICES: PITTSBURGH, PA. • PLANTS: ELWOOD CITY, PA., WARREN, OHIO • PROCESS LABORATORY: AKRON, OHIO

CONTINUOUS GALVANIZING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC

Electrolytic tinning lines maintain highest product quality through

WEAN CREATIVE ENGINEERING



VIRTUALLY since the inception of the idea, Wean has played a major role in the successful development and manufacture of equipment for the production of tin plate by the Electrolytic process. Wean-engineered tin plate lines have established outstanding production records, but of equal importance, these same lines have continuously maintained highest product standards to meet industry's ever increasing demand for quality . . . in quantity.

Wean has engineered forty-seven Electrolytic tin lines to date. Why not avail yourself of this vast specialized experience to solve your tin plate production problems?

538

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Iron and Steel ENGINEER

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GENERAL ELECTRIC ANNOUNCES . . .

NEW surface-mounted • desk-mounted mill-duty master switches

NEW SMALL SIZE

Both General Electric master switches feature new small size. The surface-mounted switch is 25 percent smaller than previous models, and the desk-mounted switch is the smallest switch of its type on the market today!

NEW PHENOLIC CAMS

Rugged phenolic cams are impregnated with graphite to increase their service life. These U-shaped cams are easily interchanged to alter the contact sequence. This is done without complete disassembly of the switch.

NEW STEEL CAM FOLLOWERS

Steel cam followers actuate the contacts with a positive action. These cam followers swing clear to allow access to internal switch components. G-E cam followers are designed for millions of operations with minimum maintenance.

NEW CONTACT BLOCKS

Unit-type contact blocks are interchangeable between both types of General Electric master switches, thus reducing the number of spare parts required. Silver-tipped contacts give long service life with little or no maintenance.

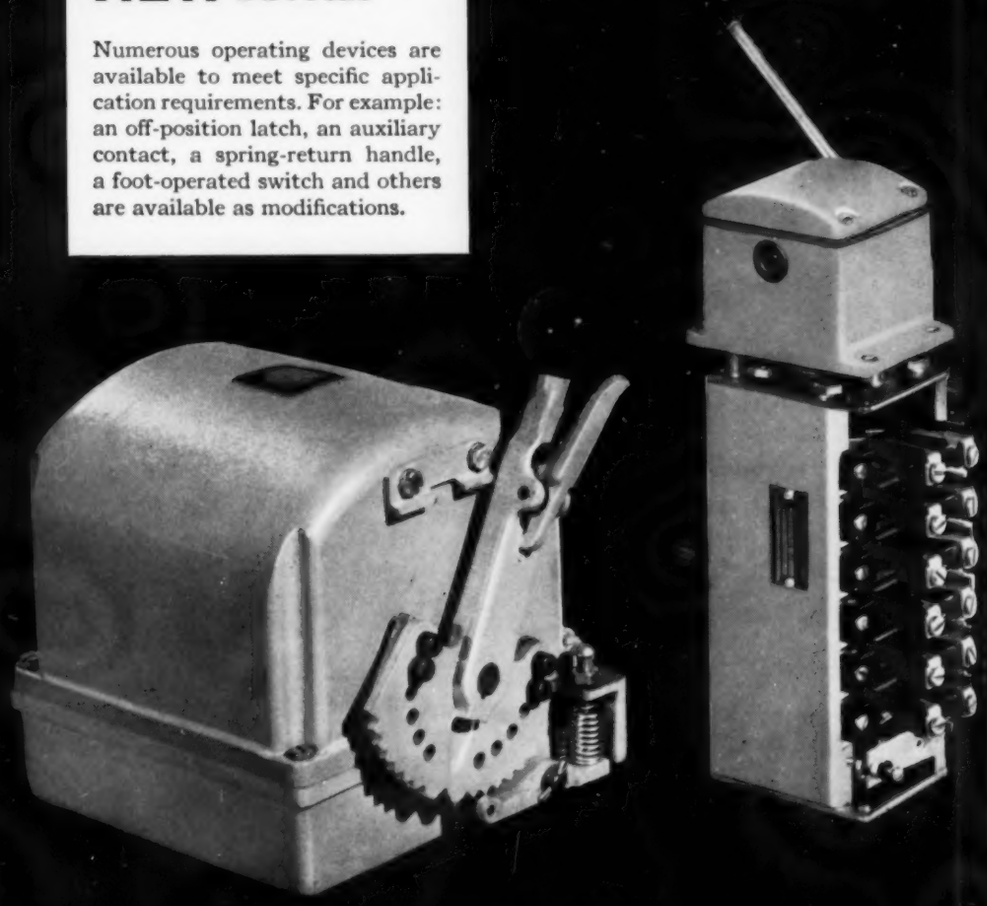
NEW OPERATING DEVICES

Numerous operating devices are available to meet specific application requirements. For example: an off-position latch, an auxiliary contact, a spring-return handle, a foot-operated switch and others are available as modifications.

NEW BULLETIN AVAILABLE

Like to know more? For complete information on General Electric's new mill-duty master switches, contact your General Electric Apparatus Sales Office. And write today for the new descriptive bulletin, GEA-6706, to Section 784-9, General Electric Company, Schenectady, N. Y.

Industry Control Dept., Roanoke, Virginia.



Progress Is Our Most Important Product

GENERAL ELECTRIC

Wide or narrow...

Low carbon or high...

Lee Wilson
High Convection Single Stack
Annealing Furnaces Assure Closer
Control of Physical Properties

Wide or narrow, low or high carbon, the Lee Wilson High Convection Single Stack Furnace is the answer to the close control of physical properties that today's steel buyers demand.

Regardless of the type of product, every charge in the Single Stack furnace is a special charge and every charge is under automatic control after the operator sets the required temperature. No burner adjustments and no guesswork! Just better, faster and more uniform annealing to meet the special needs in ductility and spheroidized structure for whatever type of steel is being processed.

Lee Wilson engineers can show you installations to fit any of these specifications. Their experience covers the entire range of annealing requirements in the steel industry.

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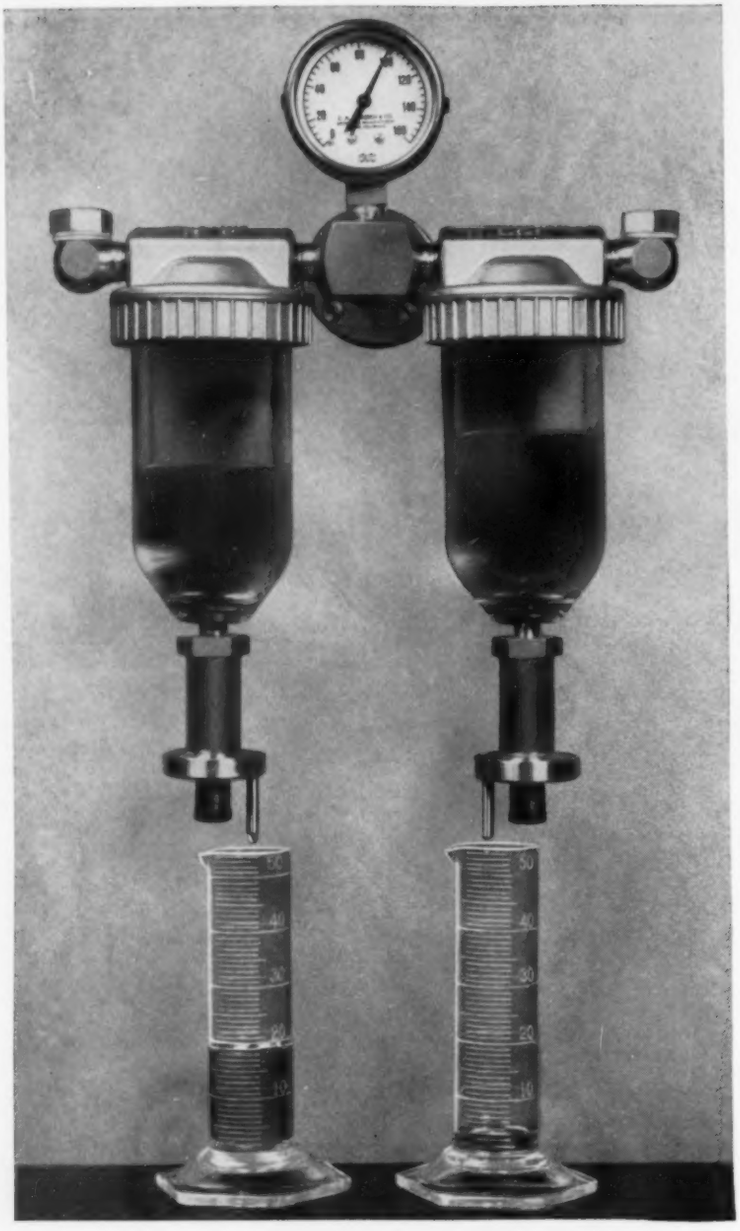
SINGLE-STACK RADIANT TUBE ANNEALING FURNACES

MAKE THE BEST METALS BETTER

* ORIGINATORS AND LEADING PRODUCERS OF SINGLE STACK RADIANT TUBE FURNACES



ANTILEAK DEMONSTRATION

Suntac oil in one chamber, your present hydraulic oil of the same viscosity in the other. Both oils are forced out through sintered bronze bearings. In this photograph, pressure of 100 psi caused a straight mineral oil to leak out four times faster than Suntac.

SUNTAC CUTS HYDRAULIC OIL LOSS AS MUCH AS 75%

See this demonstration in your plant

Take about five minutes at your own desk to learn how Suntac® oils stay put in hydraulic systems . . . reduce oil loss through loose joints and worn fittings.

Match Suntac against the hydraulic oil you're now using—see how the exceptional non-gummy antileak characteristics of Suntac can reduce your oil losses as much as 75%. *Some users have even reported savings of 90%.*

Call Your Sun Representative

Have him arrange with a Sun Lubrication Engineer to give you and your staff a private demonstration. For further information on the uses of Suntac in hydraulic systems and in general lubrication, write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. IS-12.

SUNOCO

INDUSTRIAL PRODUCTS DEPARTMENT

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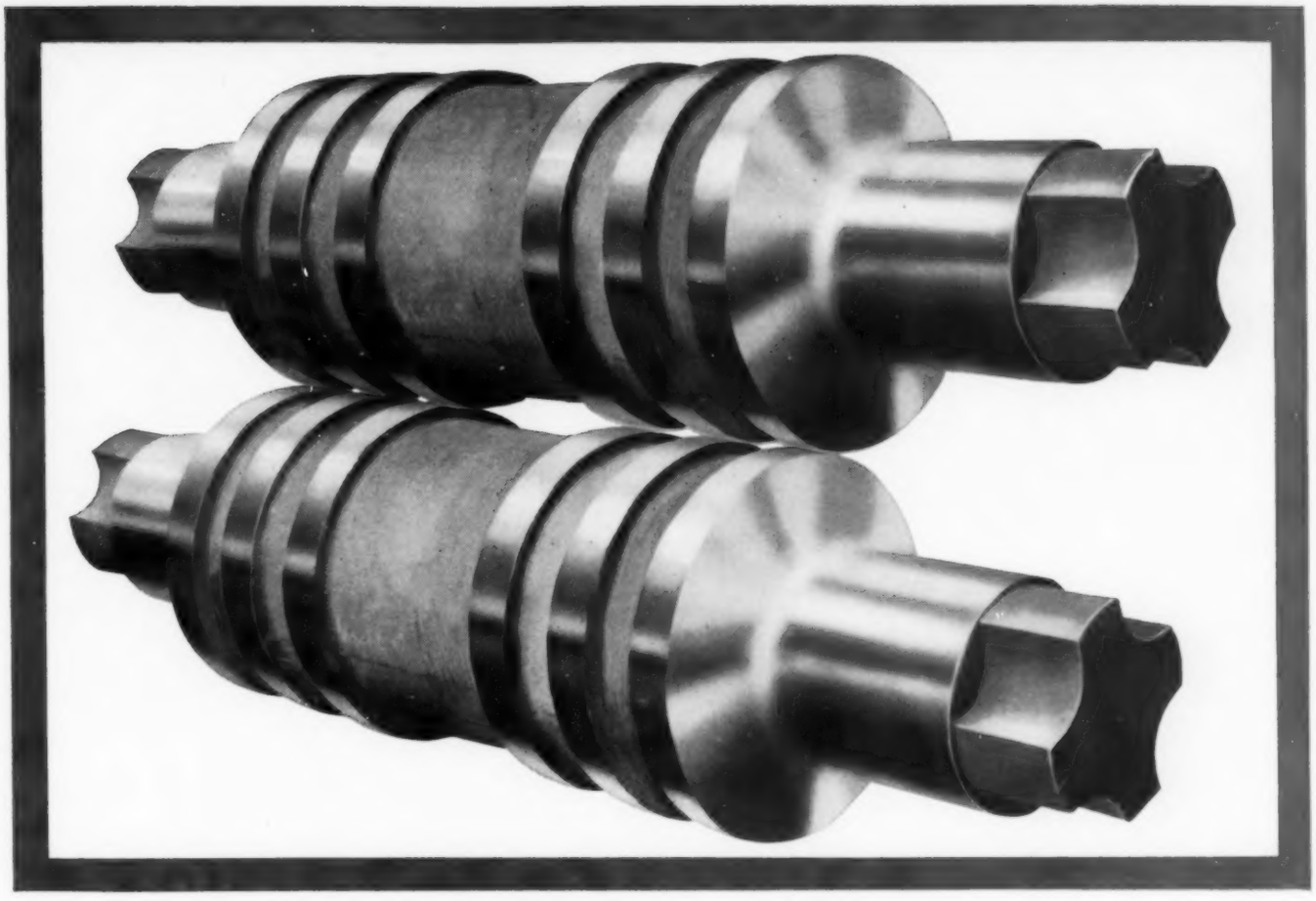

There's a PATENTED difference in BIRDSBORO'S COPPER-Alloy steel mill rolls

GREATER SUBSURFACE STRENGTH to withstand higher mechanical stress

INCREASED HEAT RESISTANCE to thermal shock of wet-to-dry and dry-to-wet rolling

DENSER STRUCTURE holds finish longer

• And the results will be easy to measure in your mill when you use Birdsboro Copper-Alloy Steel Rolls. Longer service between dressings and higher output are other benefits you get with the Birdsboro family of rolls. Ask your Birdsboro Representative about: IRON BASE ROLLS—Grainloy, Birdsboro Metal, Curoloy, Superloy, Super Curoloy; STEEL BASE ROLLS—Diamondite, Birdsboro Special, Birdsboro 30, 40, 50 and 75. *Main office and plant:* Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., *District Office:* Pittsburgh, Pa., *Subsidiary:* Engineering Supervision Co., 120 W. 42nd St., New York 36, N. Y.

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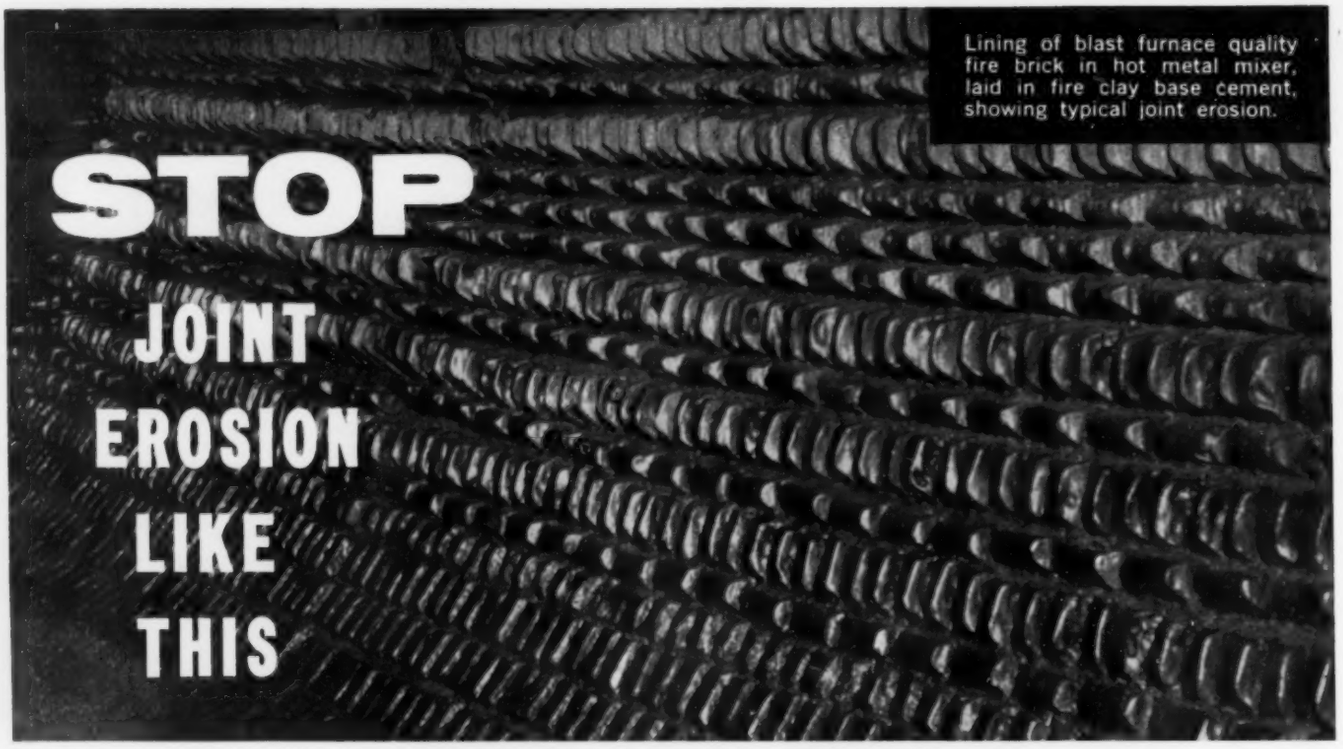
STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY • STEEL CASTINGS • Weldments "CAST-WELD" Design • ROLLS: Steel, Alloy Iron, Alloy Steel



Lining of blast furnace quality fire brick in hot metal mixer, laid in fire clay base cement, showing typical joint erosion.

WITH TASIL

Super-Refractory Cements

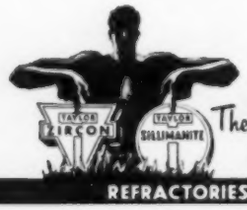
Experience has shown that the failure of refractory linings in most types of industrial furnaces usually begins at the joints in the brick work. TASIL (Taylor Sillimanite) Super-Refractory Cements are outstanding for high refractoriness, negligible shrinkage at high temperatures, and resistance to slagging and abrasion. Thus the tight, weld-like joints formed by TASIL Cements prevent joint erosion and rapid failure of the furnace lining.

TASIL Cements are recommended for bonding sillimanite or mullite, high-alumina, kaolin-type and super-duty fire brick and special shapes in any high-temperature furnace. They are especially recommended for bonding linings in:

Hot Metal Cars and Mixers
Blast Furnaces
Blast Furnace Stoves
Heating Furnaces of all types
Heat-Treating Furnaces
Salem Continuous Tube Furnaces
Electric Furnace Roofs and Sidewalls when built of Alumina-Silica Brick
Detroit Electric Furnaces
Forge Furnaces

Also excellent as a protective coating on walls and arches built of insulating fire brick

Let the Taylor field engineer in your district give you full details, or write for your copy of TASIL Cements Bulletin No. 314.



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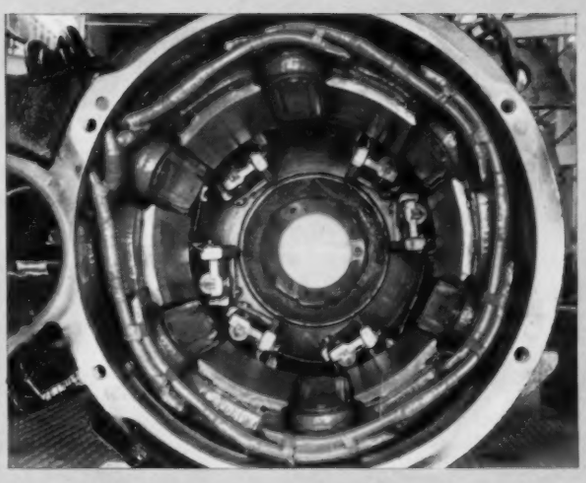
Here's why NATIONAL Plastic Molded COPPER-CLAD Field Coils

Insure Longer Service Life



The main illustration shows a plastic molded, copper-clad interpole field coil for a railway traction motor. The small photo shows a set of such coils assembled with main field coils of the same construction in a traction motor frame. For details on how National plastic molded, copper-clad field coils can help reduce your motor maintenance problems, just drop us a line or call your nearby National field engineer.

1. Snug fit on pole piece eliminates coil movement and provides maximum heat transfer to the frame.
2. Monolithic construction resists damage from mechanical stresses and insures maximum heat dissipation.
3. Void-free insulation prevents penetration of oil, moisture and other deteriorating agents.
4. Proven heat-resistant impregnant imparts high temperature endurance.

NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A.

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ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

Cleveland Cranes
FOR
STEEL MILL SERVICE

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops *and* Shorts

ANNUAL steelmaking capacity of the United States is expected to hit 140,000,000 tons of ingots by the beginning of 1958.

▲

STEEL production for 1958 is being predicted at about 105,000,000 tons of ingots. Some producers expect an irregular plateau around this figure until 1960, when a new rash of expansion is envisioned.

▲

THE old saying "Hard work never hurt anyone" is more true now than ever. No one gives it a chance.

▲

A SURVEY by the American Iron and Steel Institute showed the average age of steel employees in 1956 to be 42, with an average service record of 13 years with the present employer. Thirteen per cent of all steel industry wage employees were hired after age 40.

▲

THE average hourly payroll cost for wage earners in the industry hit a record high of $3.022 in September. This does not include an average cost of over 29 cents per hour for pensions, social security and insurance.

▲

SPENDING for plant and equipment in all industries for 1958 is expected to total about 7 per cent under 1957, about equal to 1956.

The Value Line Investment Survey looks for machinery sales to decline about ten per cent during 1958, varying somewhat from this figure in various industries.

▲

WE'VE heard a lot of complaints about automobiles constantly growing longer, wider and lower, with more and more lights and tinsely junk. But now they're talking about equipping 1959 passenger cars with—of all things—flat tires. They're to have a wider, flatter cross-section to lower car height without going to a smaller wheel.

▲

MOTOR vehicle registrations in the world in 1956 totaled 102,654,536. Of these, 65,241,260 were in the United States, including 10,752,286 trucks. In the United States, 77,869,000 drivers traveled 628,381,000,000 vehicle-miles, with traffic fatalities averaging 6.4 per 100,000,000 miles.

▲

AND then there's the termite with false teeth who walked into a tavern and said: "Is the bar tender here?"

▲

AN oxygen-process steel plant in Germany is making steel, using about 96.5 per cent hot metal from a hot blast cupola and 3.5 per cent iron ore for the charge of the 30-ton oxygen-blown converter. Blowing time ranges 19 to 22 minutes, with a tap-to-tap cycle of approximately 40 minutes, essentially the same as similar units using iron-scrap charges.

▲

A UNIQUE three-nation working agreement between Armco Steel Corporation of the United States, Compagnie des Forges de Chatillon, Commentary at Nueves Maisons of France and August Thyssen-Huette of West Germany makes the facilities of Chatillon, Commentary available to Thyssen-Huette for the production of grain-oriented electrical steel sheets under license from Armco International Corporation. Thyssen-Huette will provide the French company with hot rolled coils to be finished into electrical sheets which will then be sold in the German market by Thyssen-Huette.

As a result of the agreement, Thyssen-Huette will delay indefinitely construction of its own plant for the manufacture of these specialty steels but will rely on Chatillon, Commentary for its needs.

▲

A 69,000-KW electric generator, driven by steam from the depths of the earth will be completed in 1958 in New Zealand.

▲

IT'S hard to believe that it's here again, but the calendar which spins so rapidly nowadays says it's time to say "Merry Christmas and a happy new year."

▲

BY the time the Christmas bills are paid, a lot of us will have more fins on our cars than we have in our wallets. Of course, credit cards and the like will help to keep the wallets bulky.

MINING

CRUSHING

MILLING

SEPARATING

CLASSIFYING

FILTERING

shaft type pelletizing

units for ore beneficiation

The Erie Mining Co. pelletizing process is now available to industry through Surface Combustion Corporation. Rights for the process were secured by Surface as a climax to 12 years of cooperative development with Erie. Surface is already completing major pelletizing units in Minnesota and Canada.

Over a million tons of pellets have been produced in proving the Erie process for agglomeration of ore concentrate:

It integrates readily with any over-all beneficiation project, and its initial cost is low compared with other agglomeration methods.

Its fuel consumption is unusually low. Unequalled heat recuperation is achieved in the Surface-designed shaft furnaces used in the process.

Operation is simple and almost completely automatic. Maintenance and repair are also simple because there are few moving parts. The shaft type furnace is distinctive for its simplicity.

It is suitable for operation on a wide variety of ores.

Pelletizing is a relatively small part of ore beneficiation, but it is a crucial step which requires ingenious application of heat and mechanization. This makes it a natural field of specialization for Surface, which has devoted over half a century to improving the use of heat and mechanization in the metal producing and processing industries.

Surface engineered pelletizing units starting with the filtered concentrates are available to organizations faced with agglomeration problems.

Surface Combustion Corporation, 2404 Dorr Street, Toledo 1, Ohio.

Surface

wherever heat is used in industry

"Not once . . . but three times

ELLIOTT turbine-driven

blast furnace compressors were selected!"

Service Report

The first unit operated four years and four months without shutdown. After internal inspection, the serviceman reported, "Turbine buckets, disks, shaft, labyrinth packing diaphragms, and nozzle rings in good shape. Compressor impellers in very good condition . . . no sign of erosion . . . compressor clean throughout."

Service Report

One of the units was opened for routine inspection after three year's service. The report—*everything fine.* All three units are rated 90,000 scfm at 30 psig air discharge. These Elliott centrifugal compressor units serve one of the nation's most prominent blast furnace plants in Ohio.

Service Report

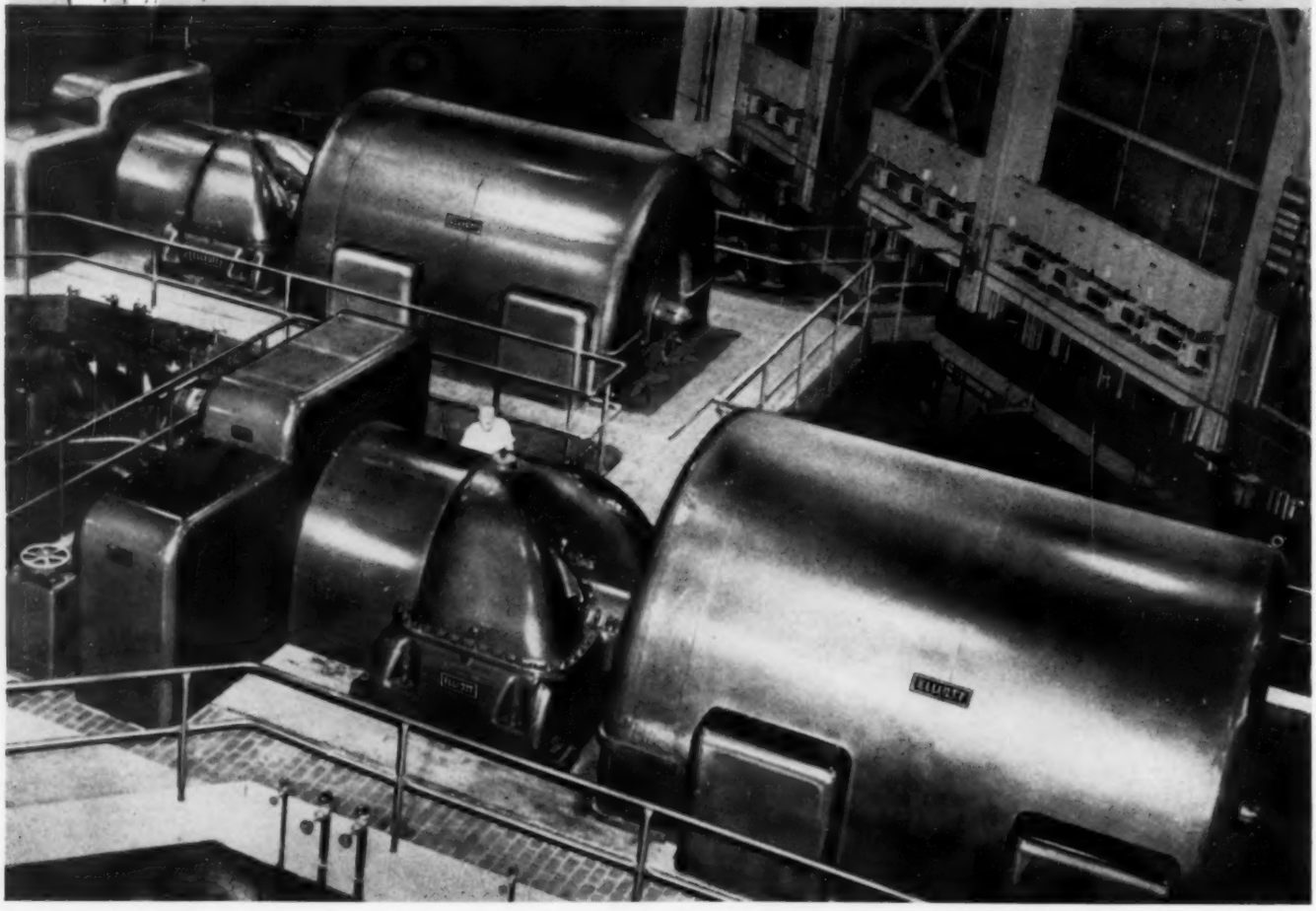
Another unit installed later duplicates the original two units seen in the photo below. This unit has operated since July, 1953—another example of Elliott's success in designing and building compressors matched to their drives to achieve maximum dependability and uniform 24-hour-a-day service.

. . . each installation has been distinguished by long-term, non-stop performance

These long, uninterrupted runs are made possible by Elliott's *all-welded impellers.* The superior performance of Elliott welded impellers has been proven by many years of experience in steel mills all over the country. What's more, Elliott blast furnace compressors are designed to match the Elliott turbine drives . . . providing a unit streamlined in appearance and capable of long, trouble-free performance. Elliott multistage compressors are available with inlet capacities up to approximately 150,000 cfm. For details, write Elliott Company, Compressor Department, Jeannette, Pa.

ELLIOTT Company

P7-5



Canada's newest steel pipe mill, completely automated, features

PUSH BUTTON DESCALING OF SKELP

Canada's Alberta Phoenix Tube and Pipe Ltd. is claimed to be the newest, most modern, automated steel pipe mill in the Western Hemisphere. It will produce approximately 150,000 tons of pipe a year ranging from 3½ to 16-in. O.D. No workman touches the pipe from the time it enters the line as skelp until it is loaded onto waiting flatcars in finished lengths. The big U-shaped mill line has an electronically controlled direct-current drive.

An integral and important section of this line is a Wheelabrator Cabinet for scouring clean the edges of the skelp to expose the virgin metal to facilitate welding. Depending on gage, the automatic resistance welder handles pipe from 30 to 80 fpm. The Wheelabrator unit has proved capable of maintaining whatever cleaning pace is required. With the entire line electronically controlled, dependability of each component is necessary to avoid excessive downtime.

The Wheelabrator mechanical descaling equipment, now being used to clean pipe skelp edges, serves to underline the versatility this process holds for the steel industry and show the high degree of control that can be achieved.

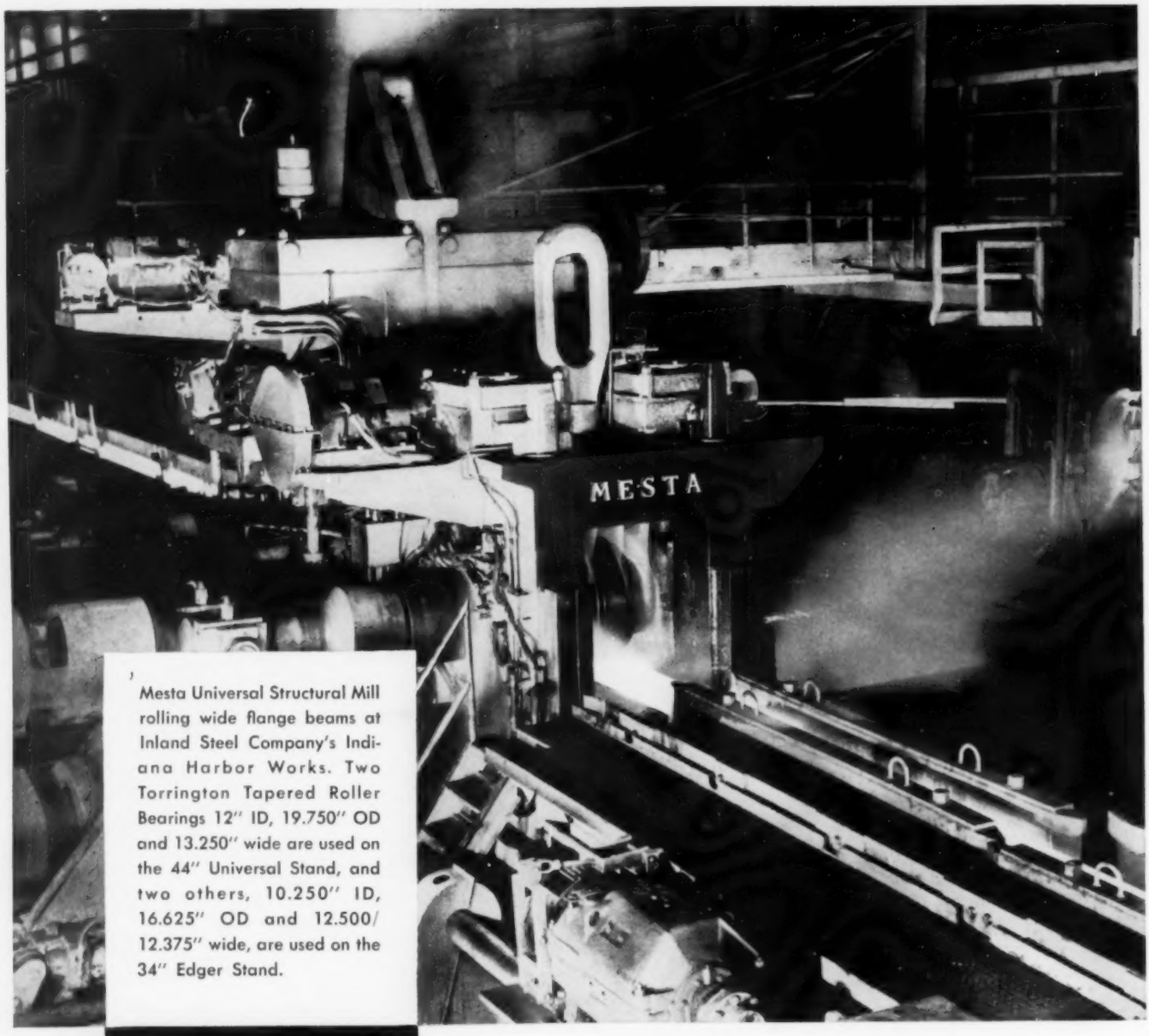
Write for details on mechanical descaling by Wheelabrator

WHEELABRATOR

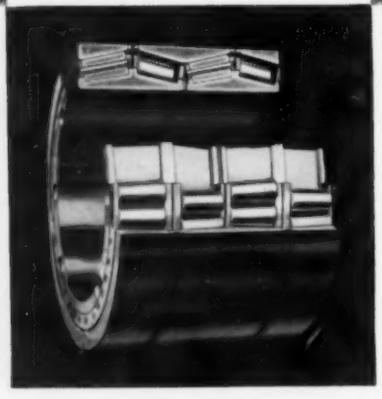
CORPORATION

396 South Byrkit St., Mishawaka, Indiana

WORLD'S LARGEST MANUFACTURER OF AIRLESS BLAST CLEANING EQUIPMENT



Mesta Universal Structural Mill rolling wide flange beams at Inland Steel Company's Indiana Harbor Works. Two Torrington Tapered Roller Bearings 12" ID, 19.750" OD and 13.250" wide are used on the 44" Universal Stand, and two others, 10.250" ID, 16.625" OD and 12.500/12.375" wide, are used on the 34" Edger Stand.



Keeping production on the beam

Bearing stamina and reliability insure consistent, uninterrupted production of structural steel beams on this 44" Universal Mill and 34" Edging Mill at Inland Steel Company.

Four Torrington Tapered Roller Bearings provide the high radial and thrust capacity to support the vertical rolls.

Every detail of their manufacture, from procurement of electric furnace, bearing quality steel to the final precision grinding, is devoted to one objective—that of providing the steel industry with the finest bearings for long, heavy-duty service.

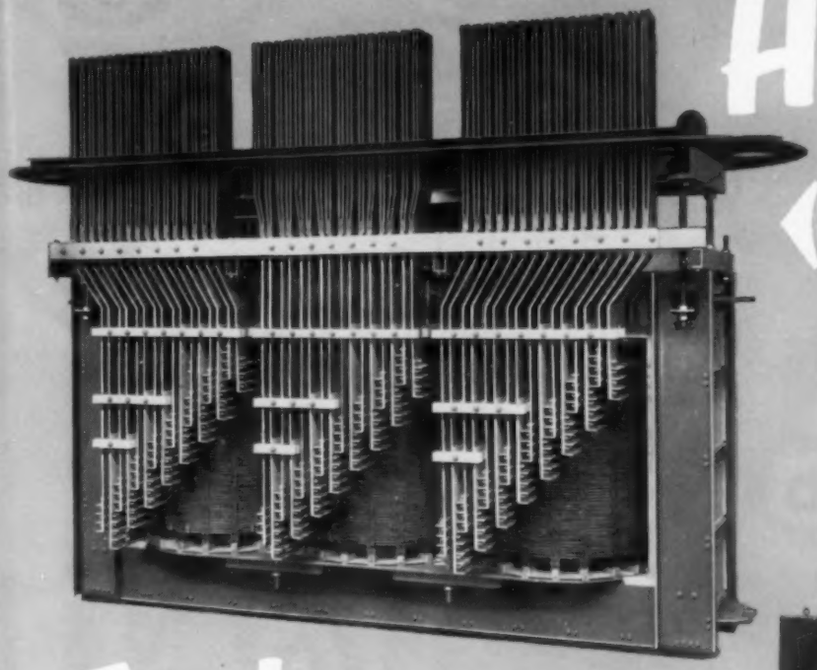
Torrington Bearings will assist you in establishing rolling mill tonnage records. Call on our engineers for assistance with your bearing problems. Their valuable experience will help insure the value of your bearing dollars! **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

TAPERED ROLLER • SPHERICAL ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

what are your FURNACE TRANSFORMER requirements?



High Current?

The **82,000-ampere** low voltage line current for which this Pennsylvania Furnace Transformer is designed is one of the highest current ratings ever provided for a furnace transformer in this country. The transformer is rated at 16,000/21,300 kva. High voltage: 13,200△ volts. Low voltage: 250△ volts with a full-capacity tap range in 10-volt steps down to 150 volts.

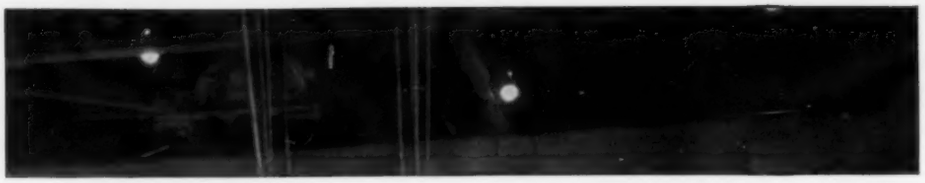
Fast Delivery?

Only **20 calendar days** were required to build and ship this 25,000-kva Pennsylvania Furnace Transformer. Even the *promised* shipping period of four weeks had looked like excellent service to the West Coast steelmaker—and by cutting this time by one-fourth, Pennsylvania saved the customer several days of costly downtime for the electric furnace involved. High voltage: 6,600 volts. Low voltage: 450 to 300 volts.

OF COURSE . . . it takes a lot of "everyday" know-how to accomplish the unusual with furnace transformers. Pennsylvania has established a nation-wide reputation for tackling and solving the most difficult problems in this highly demanding field . . . and not-so-incidentally, has designed and built virtually every size and type of furnace transformer now in use: from 250 through 25,000 kva, and from 3175 through 82,000 amperes. To put this furnace transformer experience to work for you, contact Pennsylvania Transformer Division, McGraw-Edison Company, Box 330, Canonsburg, Pa.

PENNSYLVANIA PENNSYLVANIA TRANSFORMERS pt **FURNACE TRANSFORMERS**

McGRAW EDISON



STEARNS LIFTING MAGNETS...

handle 100 tons daily at Verson

With pinpoint accuracy, a 45-inch Stearns lifting magnet easily positions a seven-ton steel plate on the pantograph flame-cutting table in the big shops at Verson Allsteel Press Company. Layout man simply guides operator, never needs to handle hoisting equipment.

Two Stearns 45-inch lifting magnets on 15-ton cranes really get a workout at Verson Allsteel Press Company, Chicago manufacturer of metal forming presses.

Typical of modern methods at Verson, the powerful magnets handle up to 100 tons of raw and finished steel daily. One man directs stock moving.

Veteran layout man Leo Potocki recalls the days when heavy steel plates were secured with awkward clamps that had to be positioned carefully for safe lifting. As Leo says, "There's just no comparison! We used to waste so much time hooking up or releasing loads — now the big Stearns magnet just comes down onto the steel and it's ready to lift right away!

"All I have to do is show where I want the load — the operator does all the rest."

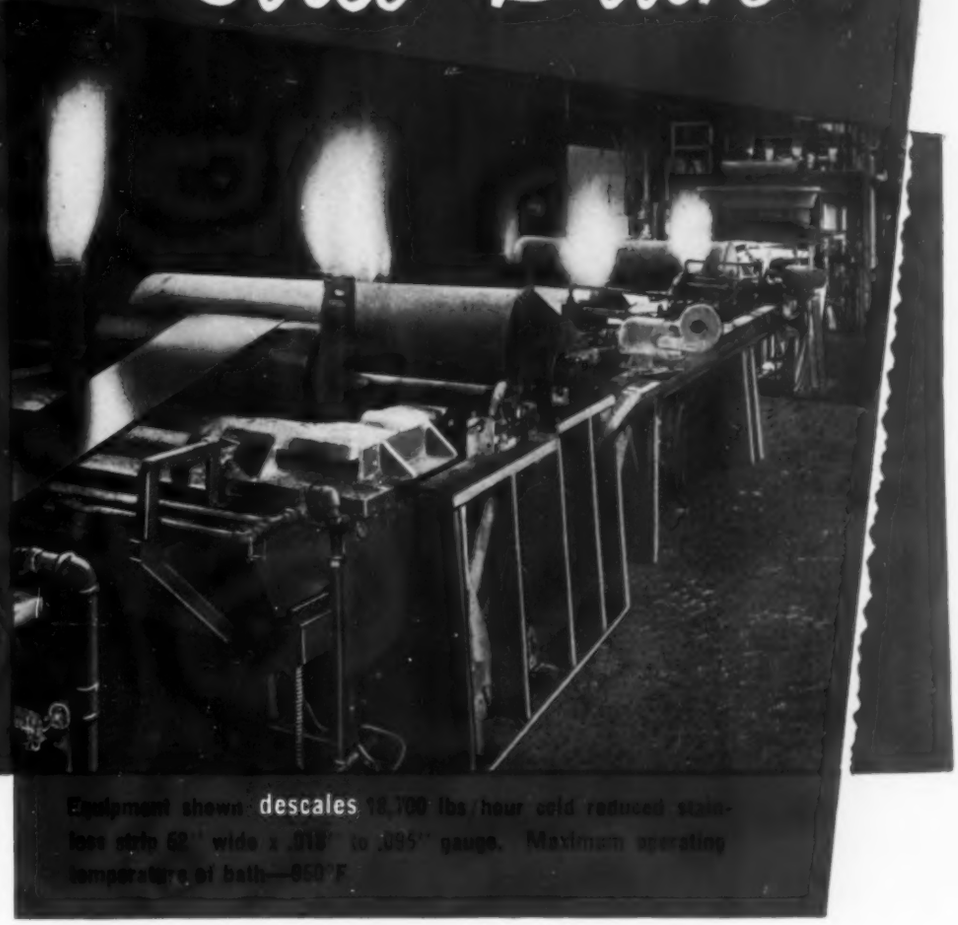
Like Verson Allsteel Press Company, modern plants in many industries have found that Stearns lifting magnets increase material handling efficiency, speed production, save time and labor. Stearns builds both rectangular and circular lifting magnets for any application, with capacities to match your requirements. Write today for free literature. Ask for Bulletin 35-CI. 28

STEARNS MAGNETIC PRODUCTS

635 SOUTH 28TH STREET • MILWAUKEE 46, WISCONSIN

DREVER Salt Bath

for CONTINUOUSLY DESCALING STAINLESS STRIP



descales

The above 35'-0" long Drever Continuous Descaling Bath will descale 18,700 lbs/hour when strip enters bath at bath temperature. Entering strip temperature is controlled by regulation of quenching temperature after strip is discharged from a catenary annealing furnace.

Drever descaling baths are heated by gas-fired immersion tubes with proportioning automatic temperature control.

Other baths are supplied for continuous or batch operation for strip, plate, wire, tubing and other ferrous or non-ferrous products.

Write for full information...

DREVER COMPANY

RED LION RD. & PHILMONT AVE. BETHAYRES, PA.

30

For The Ultimate in DUST and FUME COLLECTION Be Sure It's...

WESTERN PRECIPITATION *First* in Electrical Precipitators

Plant operators who want the finest equipment available for dust and fume collection will find nothing equal to the long life, high efficiency and low maintenance of *Western Precipitation* Electrical Precipitators.

The reason is simple— No other electrical Precipitator is backed by so many years of leadership in the field—nor incorporates so many outstanding advantages pioneered by the industry's most experienced organization in the development of Cottrell equipment—experience beginning with the world's first commercial Cottrell installation!

This cross-section of a typical Western Precipitation Electrical Precipitator shows a few of the many important details that go into the construction of these units...

CONSTRUCTION FEATURES

▶ Arrangement of curtains (1), baffles and hi-voltage wires (2) assures optimum uniformity of electrical field—therefore maximum collection efficiency.

▶ Baffles (3) insure minimum dust reentrainment and optimum gas distribution.

▶ Curtains and hi-voltage system are engineered for maximum stability, even distribution of rapper impact, and unequalled ease of installation.

▶ No moving parts in the gas stream.

▶ Supports (4) for hi-voltage system are specially designed to resist side thrusts, and require minimum maintenance.

▶ Internal stiffeners permit clean, smooth external surfaces for easy insulation (5).

▶ Air-swept insulator compartments (6) insure long life, minimum maintenance.

▶ Unobstructed free-flowing hoppers (7) permit complete dust evacuation.

ADVANCED RAPPER DESIGN

▶ Frequency and intensity of rapping is variable over wide ranges to eliminate puffing and meet individual operating requirements.

▶ All rappers (8) are external for easy adjustment and maintenance.

▶ Flexible mounting—either side or top.

SAFETY ENGINEERED

▶ Hi-voltage insulators (9) are protected by separate compartments with individual access (10).

▶ Quick-opening access (11) doors are positive-sealing.

▶ Complete interlock system available at minimum cost.

"TRANSISTOMATIC" PRECIPITATOR CONTROL

▶ No tubes, no relays, no moving parts— *carries lifetime guarantee!*

▶ *Infinitely* variable precipitator voltage to suit operating conditions.

▶ Automatically compensates for line voltage fluctuations.

Before finalizing plans for installing any dust or fume collection equipment, get the full story on the finest collection equipment available— Western Precipitation Cottrells!

WESTERN PRECIPITATION CORPORATION

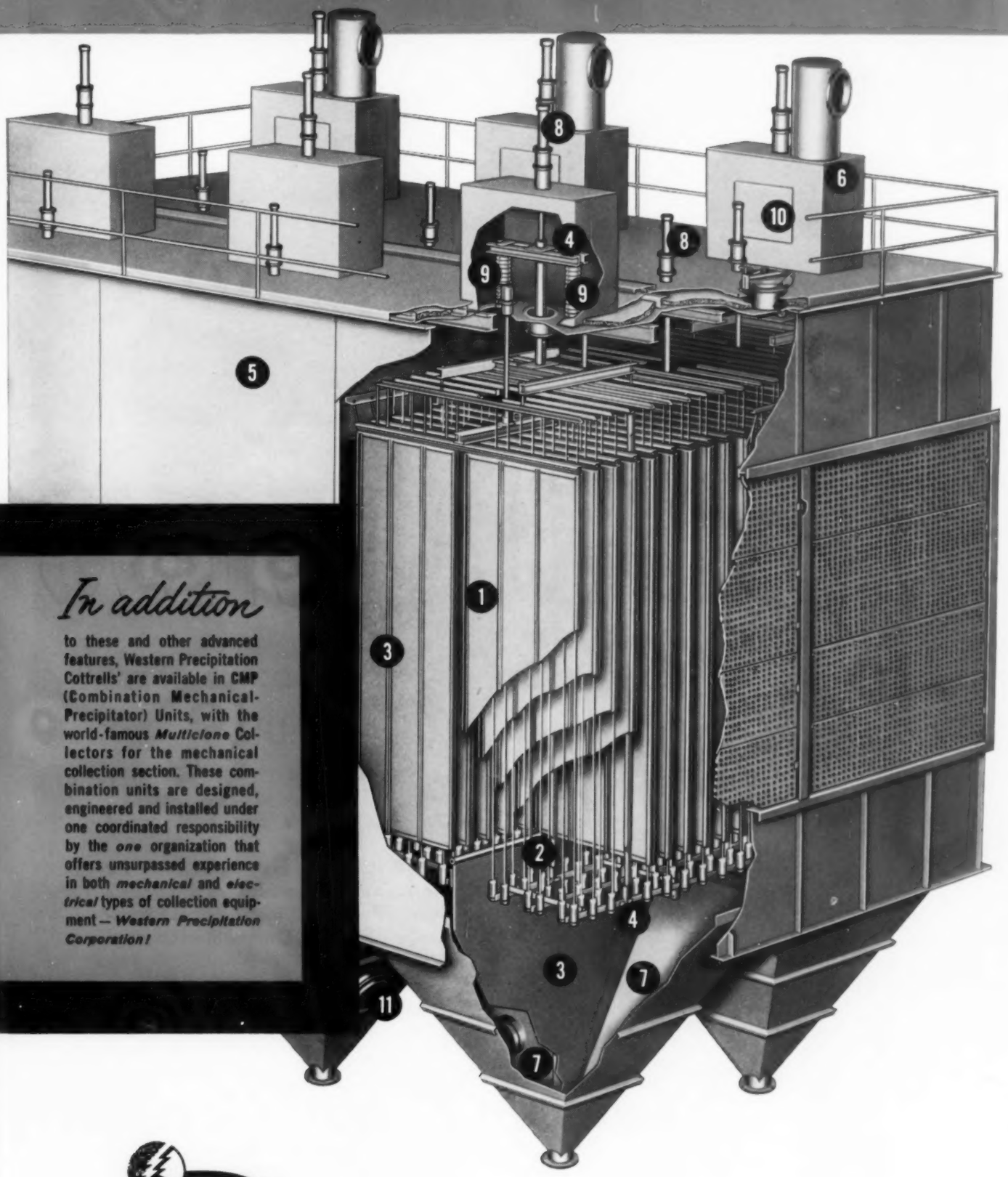
Engineers and Constructors of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries

LOS ANGELES 54 • NEW YORK 17 • CHICAGO 2 • PITTSBURGH 22 • ATLANTA 5 • SAN FRANCISCO 4

Representatives in all principal cities

Precipitation Company of Canada Ltd., Dominion Square Bldg., Montreal

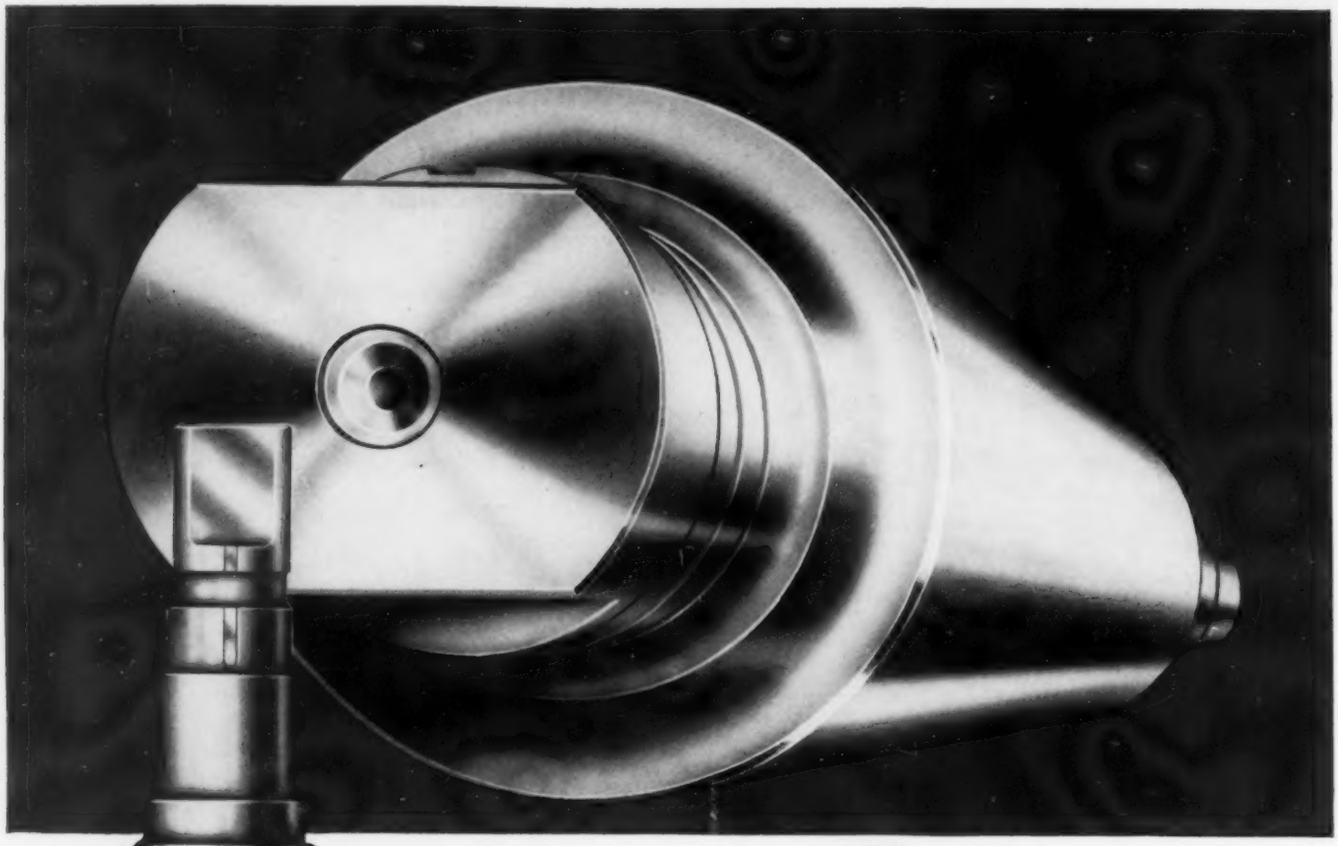
The only equipment backed by a *Half-Century of Cottrell Experience*



In addition

to these and other advanced features, Western Precipitation Cottrells' are available in CMP (Combination Mechanical-Precipitator) Units, with the world-famous ***Multiclone*** Collectors for the mechanical collection section. These combination units are designed, engineered and installed under one coordinated responsibility by the ***one*** organization that offers unsurpassed experience in both ***mechanical*** and ***electrical*** types of collection equipment — ***Western Precipitation Corporation!***

REMEMBER—*in the field of dust collection, nothing equals the long life, low maintenance and high collection efficiency of a Cottrell Electrical Precipitator!*



experience

...one of the unseen extra values you get in every

NATIONAL ROLL

In the final analysis, the quality of a roll is determined by the experience of the maker . . . Experience in metallurgy, experience in casting, experience in heat treating and machining.

For almost fifty years, National has been making rolls for the metal industry throughout the country. And now this experience is backed by the years of metallurgical experience of National's parent organization, General Steel Castings Corporation.

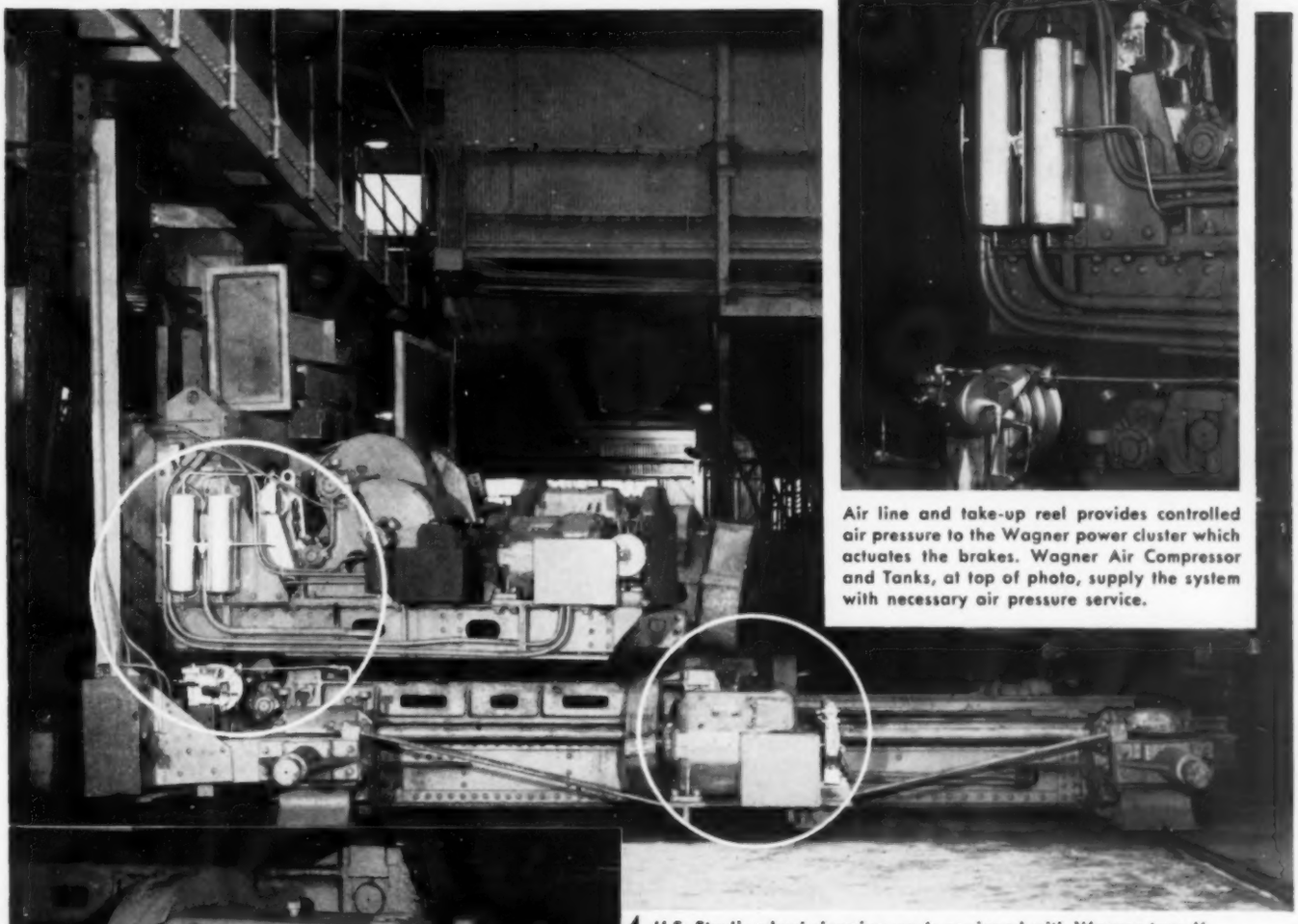
Such experience is your assurance of the best in iron and steel rolls . . . rolls that will give you dependable service, higher tonnages and longer life. Try National rolls and see.

GENERAL STEEL CASTINGS CORPORATION

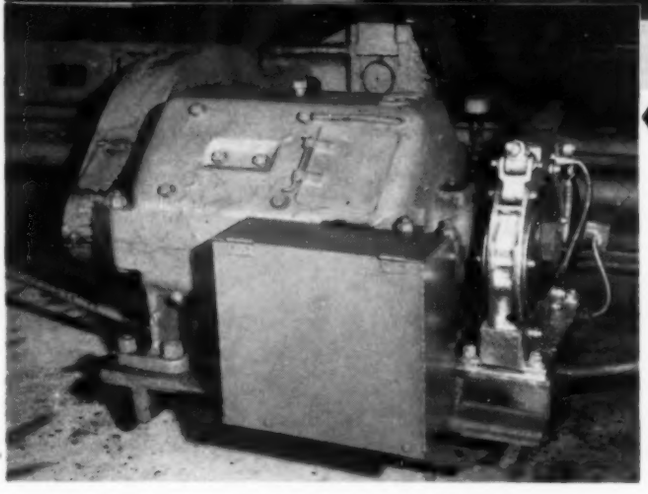
NATIONAL ROLL & FOUNDRY DIVISION

Avonmore (Westmoreland County) Pennsylvania

General Steel Castings Corporation: General Offices, Granite City, Ill.
Plants: Granite City, Ill.—Eddystone, Pa.—Avonmore, Pa.



Air line and take-up reel provides controlled air pressure to the Wagner power cluster which actuates the brakes. Wagner Air Compressor and Tanks, at top of photo, supply the system with necessary air pressure service.



U.S. Steel's wheel charging car is equipped with Wagner type H Hydraulic Crane-Bridge Brakes, as shown at left.

Wagner power brake system controls movement of wheel charging machine for U. S. Steel

This 21-ton wheel charging car at U. S. Steel Corporation, Gary, Indiana plant works at high speed to feed an automation line. It takes red hot railroad car wheels from a forging press—carefully places them in a re-heating furnace—moves them to the automated line for shaping, trueing and marking.

A Wagner Air-over-Hydraulic Industrial Power Braking System, especially designed for this application, keeps this machine under complete control. The operators can make safe, sure, precise stops with ease.

Wagner can now offer such Power Brake Systems to meet *your* requirements. Call your nearby Wagner Field Engineer—let him help you make safe, sure stops with your speeded-up charging machines.

157-1

Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wagner Electric Corporation
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

for lower maintenance

it's ohio magnets

Ohio Magnets cost less to maintain because they're built with an extra margin of safety. So for extra magnet life, extra magnet value—always specify Ohio Magnets and Ohio Magnet Controllers. There's a type and size for every lifting job. Send for free copy of Bulletin 112, or consult the Yellow Pages for Ohio offices in principal cities. AA-1478

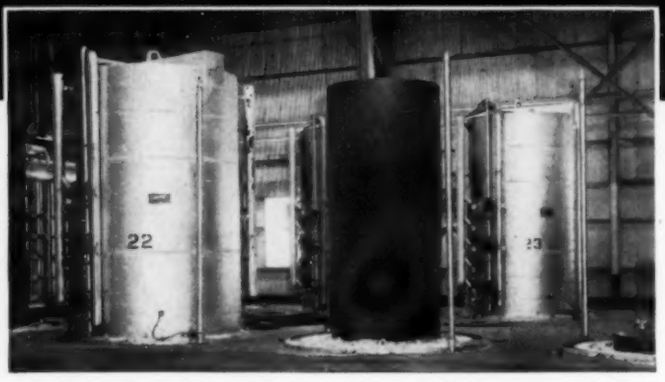
THE OHIO ELECTRIC MFG. CO.
5400 DUNHAM ROAD • MAPLE HEIGHTS
CLEVELAND, OHIO

Ohio Also Makes Separation Magnets • Nail Making Machines • Fractional Horsepower, Shell and Torque Motors

UNITED ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pa.

"Curved-Tube" assembly for single-stack annealer, centrifugally cast of Thermalloy high-heat-resistant alloy.



SPECIALLY DEVELOPED

for single-stack annealing furnaces

THERMALLOY* CURVED RADIANT TUBE ASSEMBLIES

Keeping pace with the growth of single-stack annealing, Electro-Alloys technicians, co-operating with furnace manufacturers, have developed a method of utilizing centrifugally cast tube in a curved radiant tube assembly.

The centrifugally cast tube offers many advantages inherent in this casting process—greater density, better grain structure, and uniform thickness—all of which add up to greater strength and longer service life. Now these advantages are available to you for employment in your single-stack annealing furnaces through the use of these new curved radiant tubes.

Curved radiant tube assemblies are typical of our continuing effort to develop products designed to fit the changing needs of the steel industry. We would like to work with you to develop Thermalloy castings for *your* high-heat application. Please contact your local Electro-Alloys representative or write us here at Electro-Alloys Division, 80612 Taylor St., Elyria, Ohio.

**Reg. U. S. Pat. Off.*

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION Elyria, Ohio

By MELVIN NORD Patent Attorney Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D.C. at 25 cents . . . . patents reviewed cover period July 2, 1957 through July 30, 1957 . . . .

APPARATUS FOR TREATING METALLIC STRIPS

▲ U. S. 2,797,476, issued July 2, 1957 to Tadeusz Sendzimir, describes a process and apparatus for treating work-hardened steel strip, which consists of continuously passing the strip through the following operations: brought annealing, cooling under non-oxidizing conditions, and temper rolling while maintaining the strip under tension to take up the elongation of the strip resulting from the temper rolling.

OPEN HEARTH REGENERATORS

▲ U. S. 2,797,910, issued July 2, 1957 to Andrew Usmiani, and assigned to National Steel Corp., describes an improvement in open hearth regenerators, which permits them to be operated for an increased length of time before requiring shut-down for cleaning.

As shown in Figure 1, the entrances to the checkerwork from the flue 47 are the uppermost passages 49 between bricks. As the hot exhaust gases from the furnace flow down through the checkerwork, the oxides and other dust particles collect on the bricks forming the uppermost courses. Eventually, the uppermost passages become so clogged that it is necessary to shut the furnace down in order to clean these passages, even though the lower passages may still be relatively clear.

In the present invention, however, it is not necessary to shut down at this time, as the gases may be diverted around the uppermost courses, by removing bricks 54 in the sidewall of the checkerwork. This is accomplished by pushing them out of the way with rods 100.

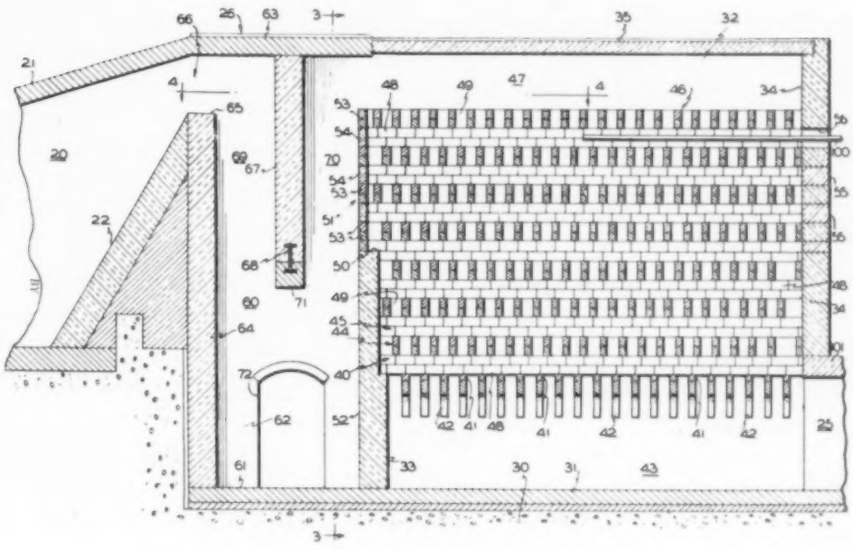


Figure 1

TREATMENT OF WASTE FERROUS SULPHATE LIQUORS

▲ U. S. 2,798,802, issued July 9, 1957 to Tuhin K. Roy and Louis N. Allen, Jr., assigned to Chemical Construction Corp., relates to a method for the treatment of spent pickle liquor and similar ferrous sulphate wastes for the recovery of valuable products therefrom.

As shown in Figure 2, spent pickle liquor and hydrated lime slurry are introduced into a precipitation tank 1, in stoichrometric proportions suitable for neutralizing all of the free acid of the spent pickle liquor and for converting its ferrous sulphate content into the hydroxide or hydrated oxide or iron. The resulting precipitate is filtered on a rotary vacuum filter 2, and the filtrate is discarded. Since the filtrate is neutral and contains little or no dissolved compounds, it may be discharged to a stream without creating any pollution hazard.

Since the neutralization tank 1 is open to the air and the precipitate is contacted with air on the filter 2, most of the iron is probably converted into ferric hydroxide.

The filter cake is discharged into a slurry tank 3, where it is suspended in water by means of an agitator 4. The quantity of water is such that a 35 to 45 per cent ammonium sulphate solution is obtained in the subsequent reaction of the slurry with ammonia and carbon dioxide.

The reactor 5 consists of an autoclave 7 and an external reaction coil 8 having inlets for the introduction of ammonia and carbon dioxide. The calcium sulphate formed in the neutralization step is converted into calcium carbonate and ammonium sulfate.

The slurry of iron hydroxide and calcium sulphate is recirculated from the reactor 7 through the pipe system 8 by pump 9 at 70 C and 20 to 50 psig. aside stream is withdrawn continuously through line 10

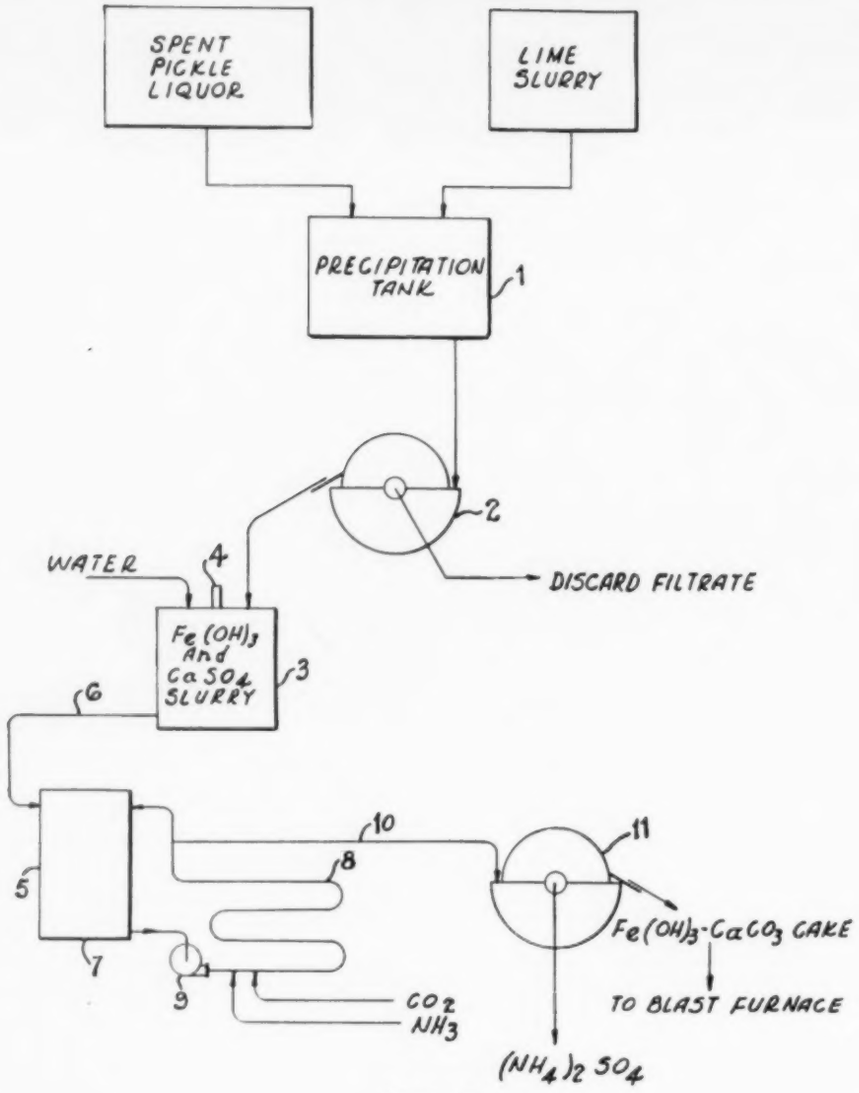


Figure 2

and is filtered on a filter 11. The filtrate, consisting of ammonium sulphate in water, may then be concentrated and crystallized. The ammonium sulphate produced is suitable for use as a fertilizer. The filter cake, which consists of a wet mixture of iron hydroxide and calcium carbonate, may be pelletized in a rotary drum and dried by contact with hot combustion gases in a rotary kiln. The resulting dry mixture is an ideal blast furnace feed, since it is entirely free from sulphur and contains the iron in a highly reactive form. The calcium carbonate is, of course, useful as a fluxing material during the smelting process.

APPARATUS AND METHOD OF FILLING INGOT MOLDS

▲ U. S. 2,799,906, issued July 23, 1957 to William M. Duncan, relates to a method and apparatus for pouring ingots in such a way as to avoid formation of piping.

As shown in Figures 3 and 4, molds 1 are arranged in a row for relative movement with respect to a pouring station. The molds are carried by trucks 3, which are coupled together at 7, and the trucks are moved along a track 5 in the direction indicated. The molds are conventional ingot molds, with cavities 9 and relatively large open tops 11 through which the finished ingots are removed. The track 5 is on a slight incline, in the direction of mold movement, and the molds are connected together at their tops by runners. The runners may be formed by covers or lids 13, which are flat rectangular members of refractory material. A groove 15 in the upper surface of each member functions to channel the flow of liquid metal between walls 17, and at the ends of the groove are recesses 19, which form relatively small sprue openings for filling the molds.

Metal is poured into the runner from a ladle 21 located at a point near the upper end of the inclined part of the track. At the beginning of a pouring operation, the initial mold is moved beneath the ladle 21 and filled. When filled, the mold is not immediately moved from beneath the ladle, but liquid is allowed to flow over the sprue while the metal in this initial mold cools and sets. Thus, a continuous supply of hot liquid metal is present at the sprue to feed whatever shrinkage occurs, the excess being directed by the runner 15 into a following mold. After the possibility of shrinkage at the first mold has passed, the molds may be moved continuously as a unit until the pouring operation is completed.

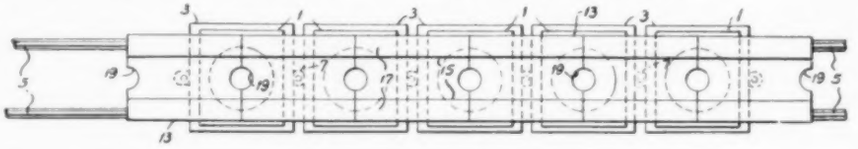
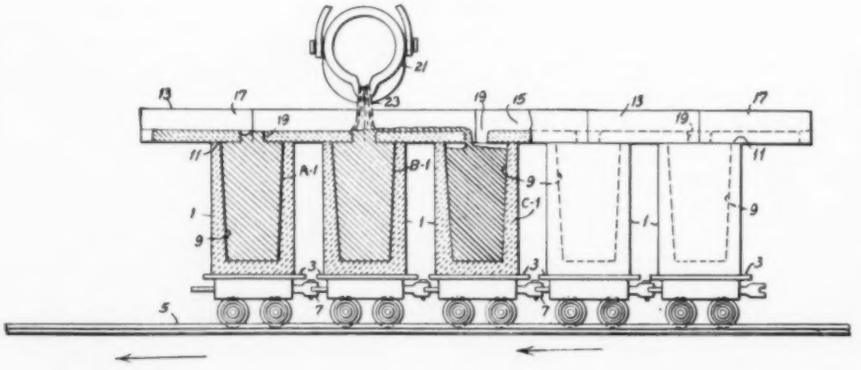
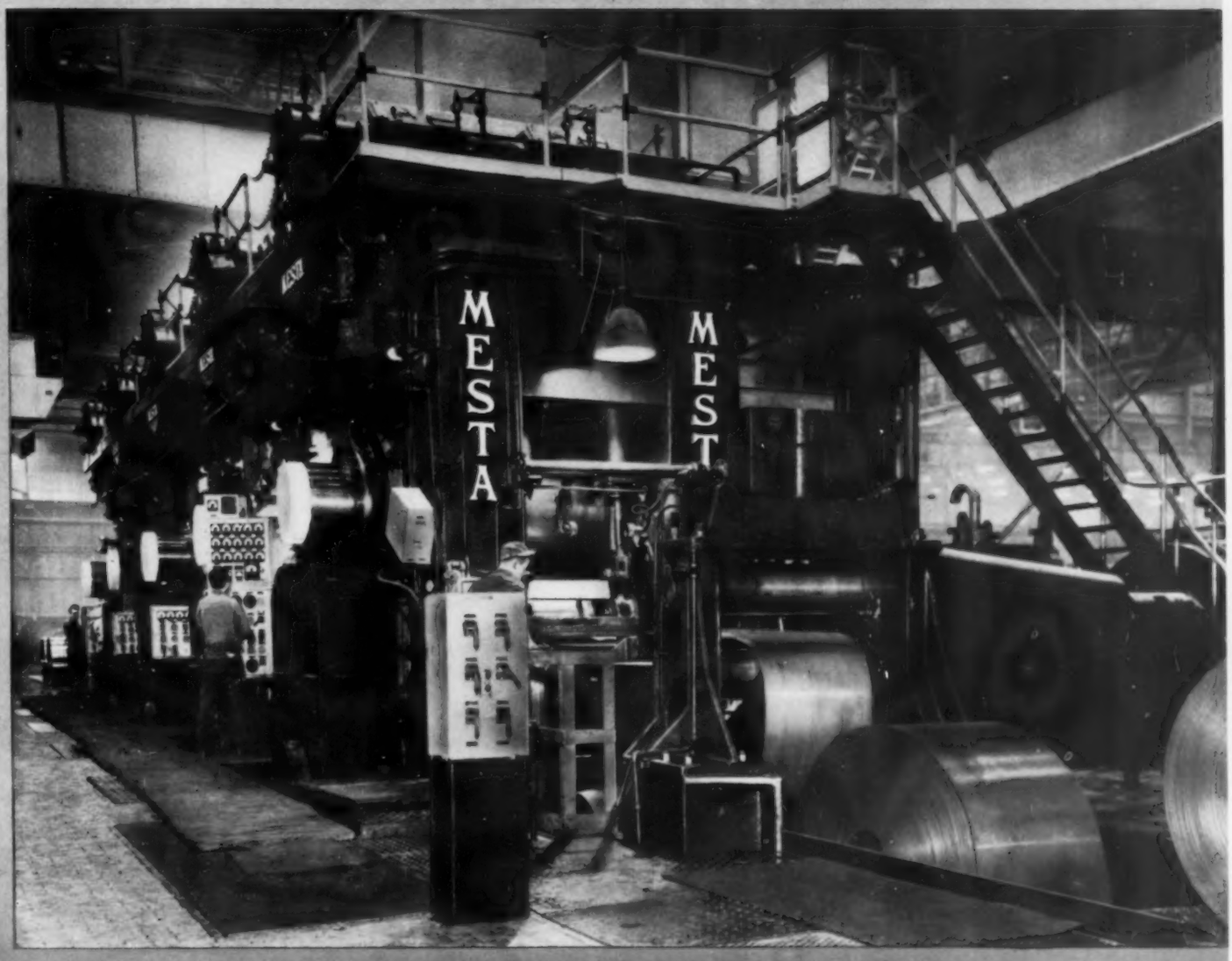


Figure 3

Figure 4





Mesta 48" Four-High, Five Stand
High-Speed Tandem Cold Mill

Designed and Built by MESTA

The World's *HIGHEST SPEED* Cold Mill
FOR FAIRLESS WORKS,
U. S. STEEL CORPORATION

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY, PITTSBURGH, PENNSYLVANIA

Used where metals and slags are poured . . .

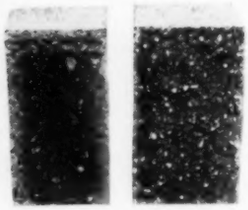
HARBISON-WALKER
BLACK PATCH
Plastic Graphite Refractory

- *reduces costs*
- *improves service*
- *assures cleaner metal*

Monolithic linings formed with H-W BLACK PATCH withstand severe corrosive and erosive action of various metals and slags, resist wetting and penetration and remain cleaner because there is less slag adherence.

When heated, H-W BLACK PATCH develops a strong ceramic set and a close texture which, together with the oxidation inhibitors, greatly retard burning of the carbon. In addition, the graphite component enhances the high resistance to thermal shock and increases the refractoriness of H-W BLACK PATCH.

NEW ZIP-OPEN CARTON aids in efficient handling of the plastic slabs. H-W BLACK PATCH is available in the form of plastic slabs 12″ x 9″ x 1″; in a compact mass in drums; or as a dry mixture in sacks, for mixing with water when used.



5-HOUR HIGH TEMPERATURE TEST SHOWS BLACK PATCH SUPERIORITY

Result of 5-hour test at 2730°F. Note difference in degree of oxidation. Test piece at left—ordinary graphite plastic; at right—H-W BLACK PATCH.

Some of the many important applications in which H-W Black Patch serves to advantage:

- HOLDING LADLES
- POURING LADLES
- BLAST FURNACE RUNNERS
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Another Quality Product of the World's Most Complete Refractories Service

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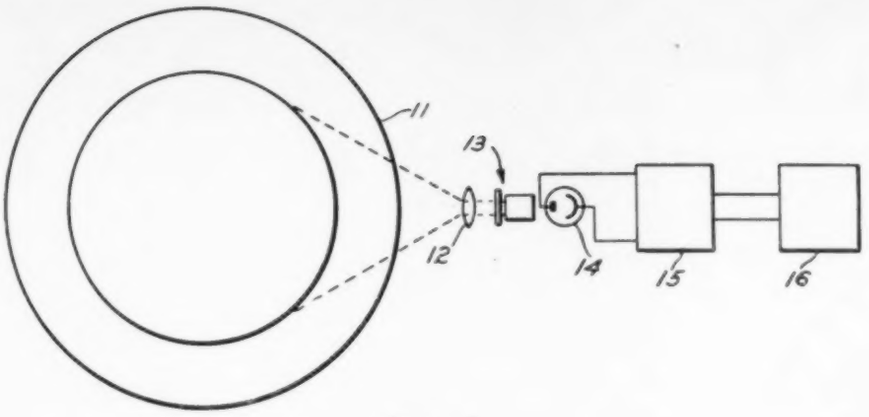


Figure 5

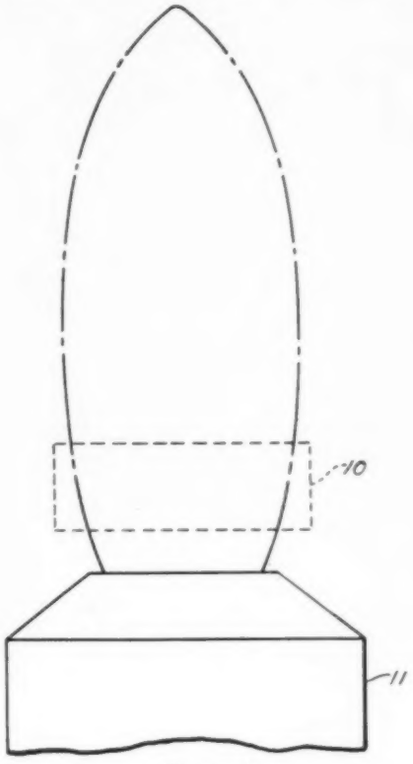


Figure 6

STRIP FEEDING LINE

▲ U. S. 2,800,327, issued July 23, 1957 to Kenneth L. Bandy and assigned to The McKay Machine Co., relates to apparatus for feeding strip or sheet from a coil into a press, shear, or other allied apparatus.

An object of the invention is to provide a strip line apparatus including a raised intermediate strip supporting stand, positioned between the pull-off stand and the feeder stand by means of which the strip may be directed through two relatively small loops aggregating the total desired loop capacity. In this manner, it is possible to avoid the use of a conventional looping pit.

STIFFENING OF SLAGS

▲ U. S. 2,800,405, issued July 23, 1957 to Rudolf Rinesch, assigned to Vereinigte Oesterreichische Eisen- und Stahlwerke A.G., relates to a process for the stiffening of slags on liquid metal baths before pouring them off.

The invention consists of cooling down the liquid slag by addition of congealed slag of the same composition. Thus, no chemical reactions occur which could affect the quality of the metal. Furthermore, the quality of the slag remains unchanged.

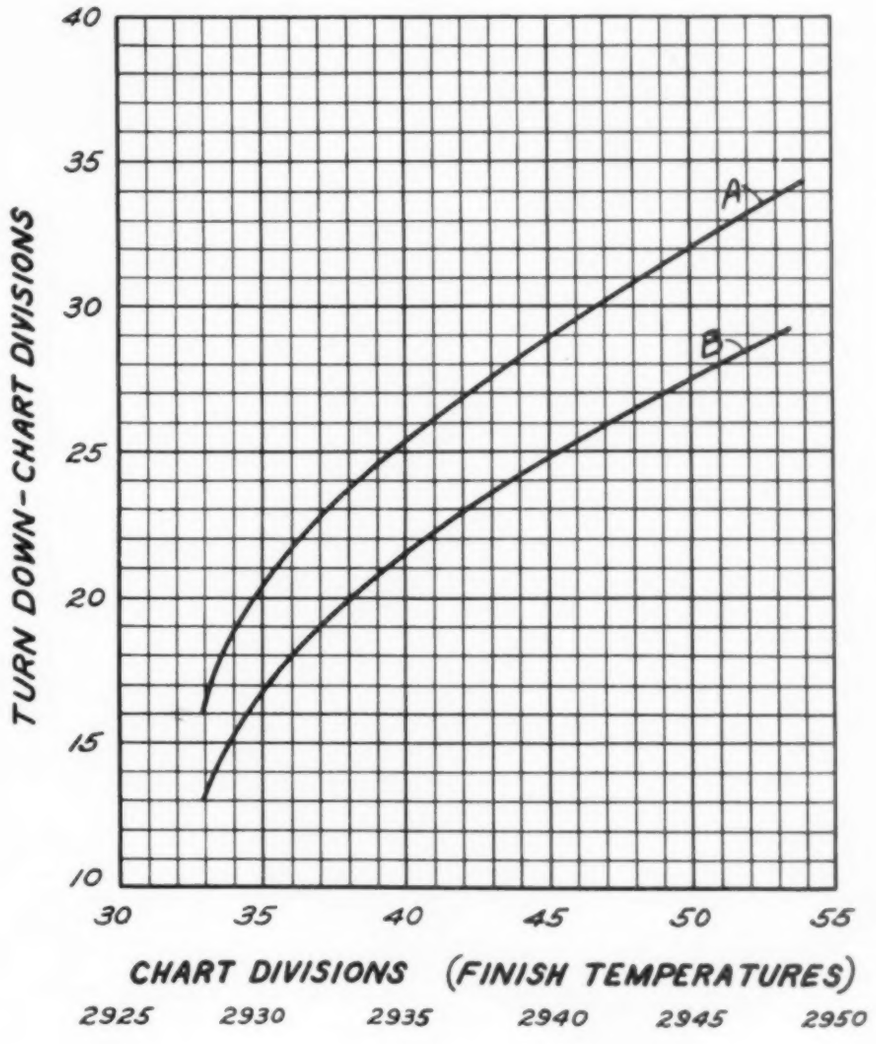
PROCESS FOR OPERATING A BESSEMER CONVERTER

▲ U. S. 2,801,161, issued July 30, 1957 to Donald W. Murphy and assigned to Bethlehem Steel Co., relates to a process for operating a bessemer converter which involves the determination of bath temperatures during the heat and control of the operation in accordance with such temperature determinations.

In spite of the importance of temperature control in the operation of a bessemer converter, up to the present time there has been no objective, quantitative, method of determining the metal temperatures during the blow.

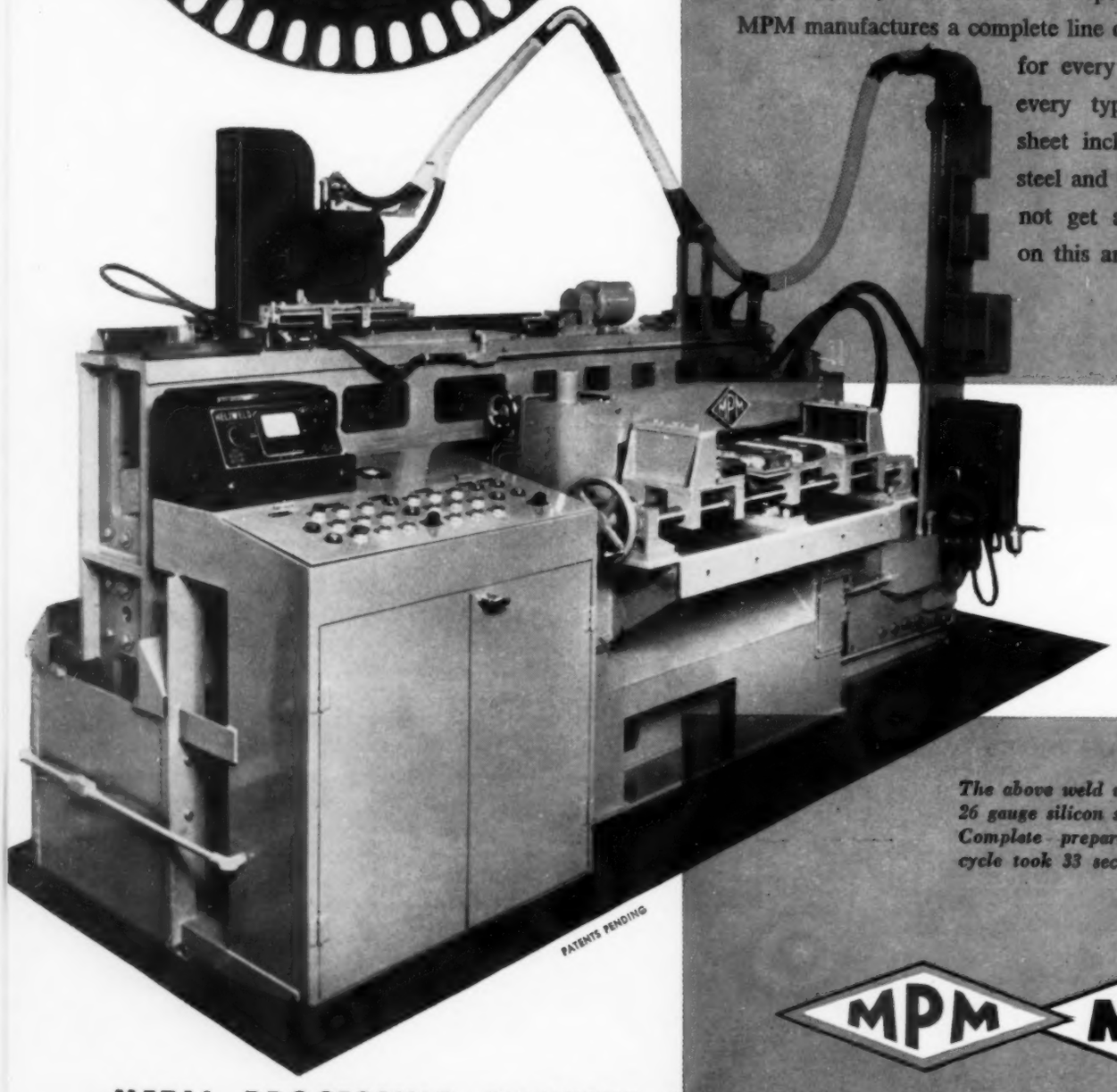
The invention is based on the

Figure 7



Silicon steel coil buildup made faster, more accurate by amazing MPM shearwelder

• The unretouched photo of the rotor lamination is a typical production butt-weld made on 26 gauge silicon steel by MPM's outstanding new Shearwelder. Perfect welds like this are a result of the exclusive positive guiding and clamping arrangement and welding technique developed by MPM engineers. Both shearing and welding are performed at the same station eliminating the chance for error that occurs when the work is moved from station to station, too, this MPM method speeds the operation. MPM manufactures a complete line of Shearweiders for every need, and for every type of strip and sheet including stainless steel and tin plate. Why not get all the facts on this amazing machine?



The above weld was made in joining 26 gauge silicon steel sheet 33" wide. Complete preparation and welding cycle took 33 seconds.

MPM McK

METAL PROCESSING MACHINE COMPANY • YOUNGSTOWN, OHIO

Subsidiary of THE McKAY MACHINE CO.

discovery that the measurement of the radiation of the bessemer flame during the carbon blow gives an indication of metal bath temperatures, providing the radiation measured is confined to the narrow band of wave lengths from 0.32 to 0.36 micron. This band contains as characteristic radiation only that radiation due to iron. The intensity of this radiation is a function of the temperature in the molten metal. Since iron is the one constituent of the bath the amount of which remains relatively constant from start to finish of the blow, radiation from iron in the flame can be relied on to give a stable indication of the metal temperature at any time during the blow.

Figures 5 and 6 show an arrangement of the apparatus, whereby radiation from a zone 10 above a bath of molten metal in a bessemer converter 11 is measured. Radiation from this zone is directed via a lens system 12 through a filter 13 onto a photosensitive device 14 such as a phototube. The phototube is connected via an amplifying device 15 to an indicator 16.

Figure 7 shows the upper (A) and lower (B) limits of the range in which the turndown point for a given finish temperature will be located.

Figure 8 is a curve showing the progress of a particular heat. As will be seen from the curve, the highest chart division number reached during the last 30 seconds of the blow was number 45, which corresponds to a finish temperature of 2940 F. Referring to Figure 7, it will be seen that this temperature corresponds to division numbers in the range 25–29. The converter should therefore be turned down when the reading has dropped to point X, or 25.

CUPOLA STOCK LINE INDICATOR

▲ U. S. 2,801,311, issued July 30, 1957 to Leo A. Gionet and Vernal P. Davel, assigned to Modern Equipment Co., relates to improvements in cupola stock line indicators.

The apparatus utilizes a horizontal plunger which is moved inwardly into the cupola. Depending on whether or not an obstruction stops the plunger from being projected its maximum distance into the cupola, a signal is emitted showing whether or not further charging is permissible.

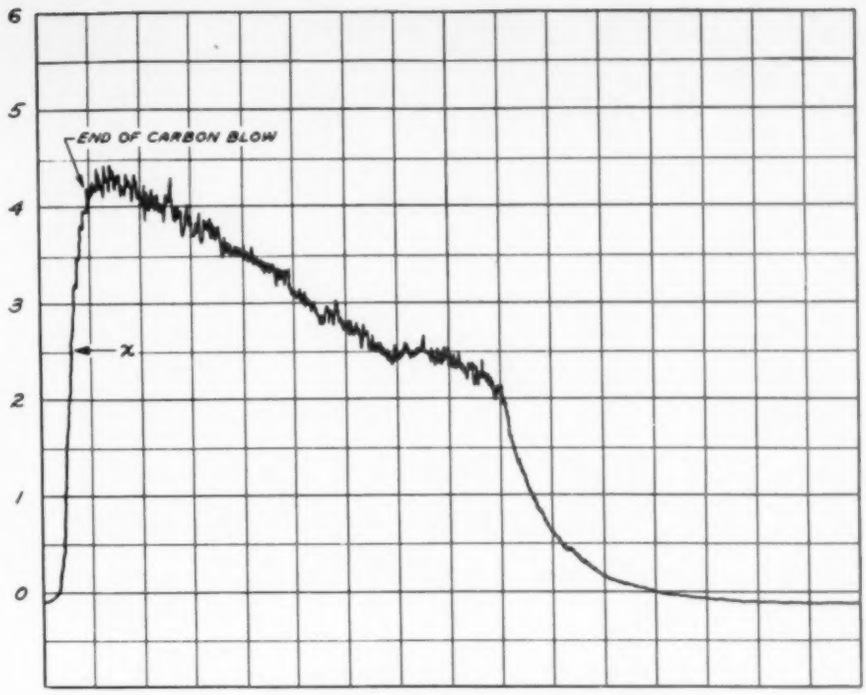
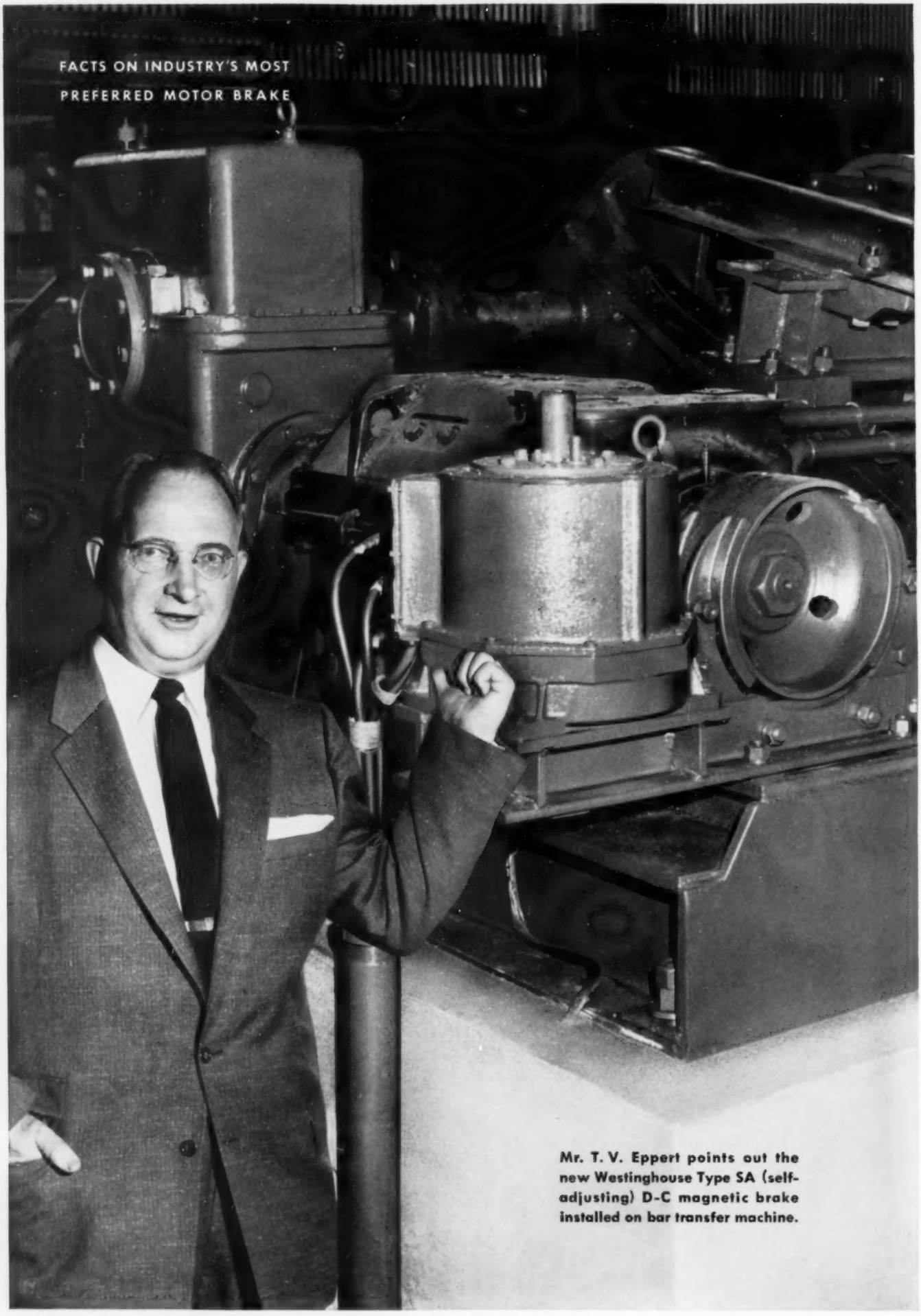


Figure 8

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,797,532	7/2/57	Billet grinder	Crucible Steel Co. of America
2,797,918	7/2/57	Apparatus for speed and strip tracking control	The Wean Engineering Co., Inc.
2,797,989	7/2/57	Production of sponge iron with gas as reducing agent	Norsk Hydro-Elektrisk Kvaelstofaktieselskab
2,797,991	7/2/57	Low alloy steel	National Steel Corp.
2,797,993	7/2/57	Stainless steel	Armco Steel Corp.
2,798,268	7/9/57	Ingot mold plug	Donald D. Whitacre
2,798,269	7/9/57	Method of resurfacing worn machine parts	United States Steel Corp.
2,798,758	7/9/57	Self-dumping bucket-and-bail container	United States Steel Corp.
2,798,805	7/9/57	Wrought railroad wheels made of alloy steels	United States Steel Corp.
2,799,067	7/16/57	Bottom rings for hot tops	The Ferro Engineering Co.
2,799,492	7/16/57	Steelmaking plant construction	Oesterreichisch-Alpine Montangesellschaft
2,799,493	7/16/57	Cupola furnace construction	Lloyd E. Brownell et al.
2,799,571	7/16/57	Method of using blast furnace fluedust	United States Steel Corp.
2,799,572	7/16/57	Iron ore pelletizing process	The Cleveland-Cliffs Iron Co.
2,799,576	7/16/57	Process for operating shaft blast furnaces	W. Strikfeldt & Co.
2,799,602	7/16/57	Production of stainless steel	Allegheny Ludlum Steel Corp.
2,799,605	7/16/57	Continuous heating of steel strip	Bethlehem Steel Co.
2,799,606	7/16/57	Method of quenching to harden steels	Michael W. Freeman
2,799,632	7/16/57	Recirculation underjet coking retort oven	Koppers Co., Inc.
2,799,678	7/16/57	Method of recovering pyridine and tar bases from hot coke oven gases	United Engineers & Constructors Inc.
2,800,179	7/23/57	Flying shears for cutting a running band of steel	Fritz Ungerer
2,800,288	7/23/57	Strip uncoiler and control	The McKay Machine Co.
2,800,317	7/23/57	Heat treating furnace	Harold N. Ipsen
2,800,318	7/23/57	Slot furnace	George E. Markley
2,800,319	7/23/57	Apparatus for sintering ore	William M. Duncan
2,800,420	7/23/57	Continuous cleaning of metal strip	Kolene Corp.
2,800,421	7/23/57	Composition and method for coating stainless steel	Parker Rust Proof Co.
2,800,422	7/23/57	Process for rust-proofing and passivating iron articles	Achille Piccinelli
2,800,435	7/23/57	Coke oven door closure apparatus	Koppers Co., Inc.
2,800,519	7/23/57	Apparatus for forming ingots	Republic Steel Corp.



Mr. T. V. Eppert points out the new Westinghouse Type SA (self-adjusting) D-C magnetic brake installed on bar transfer machine.

FACT:

Brake shoe adjusting eliminated with this new SA* motor brake

The self-adjusting feature of the new Westinghouse type SA, d-c magnetic brake in itself will bring your brake maintenance costs to their lowest levels. And that's just part of the story.

There are many added cost-cutting features of the type SA described completely in Booklet B-6548.

Get it from your Westinghouse sales engineer or write Westinghouse Electric Corp., 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pa.

J-21907

*** Self-adjusting**

Lining life is increased because the self-adjusting brake shoe feature keeps both shoes in correct alignment with the wheel at all times. Shoe tips cannot drag—wheel scoring is minimized.

Magnetic housing is easily removed for coil accessibility. Coils can be repaired on the spot. No need to return them to the factory. Housing will hold either shunt or series coils.

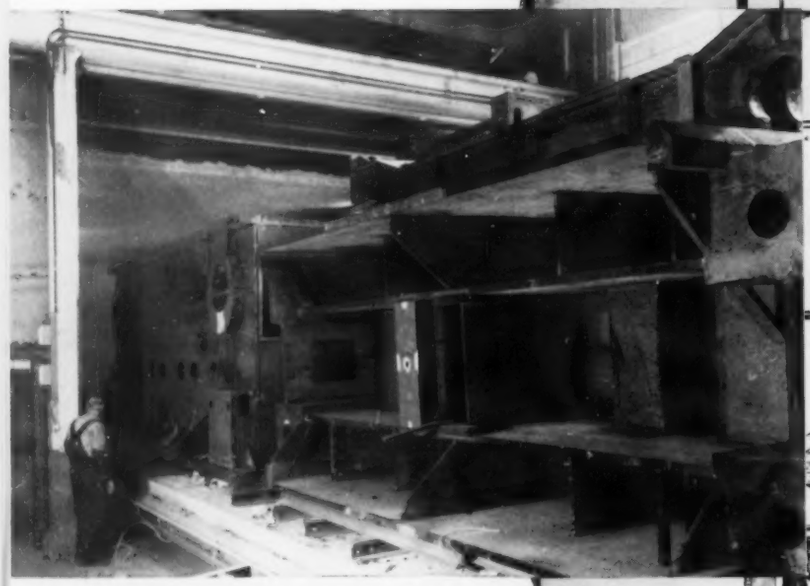
Torque rating scale, stamped on spindle, takes the guesswork out of torque setting. Rated torque is factory-set and needs no changing. A clockwise turn reduces torque.

YOU CAN BE **SURE**...IF IT'S

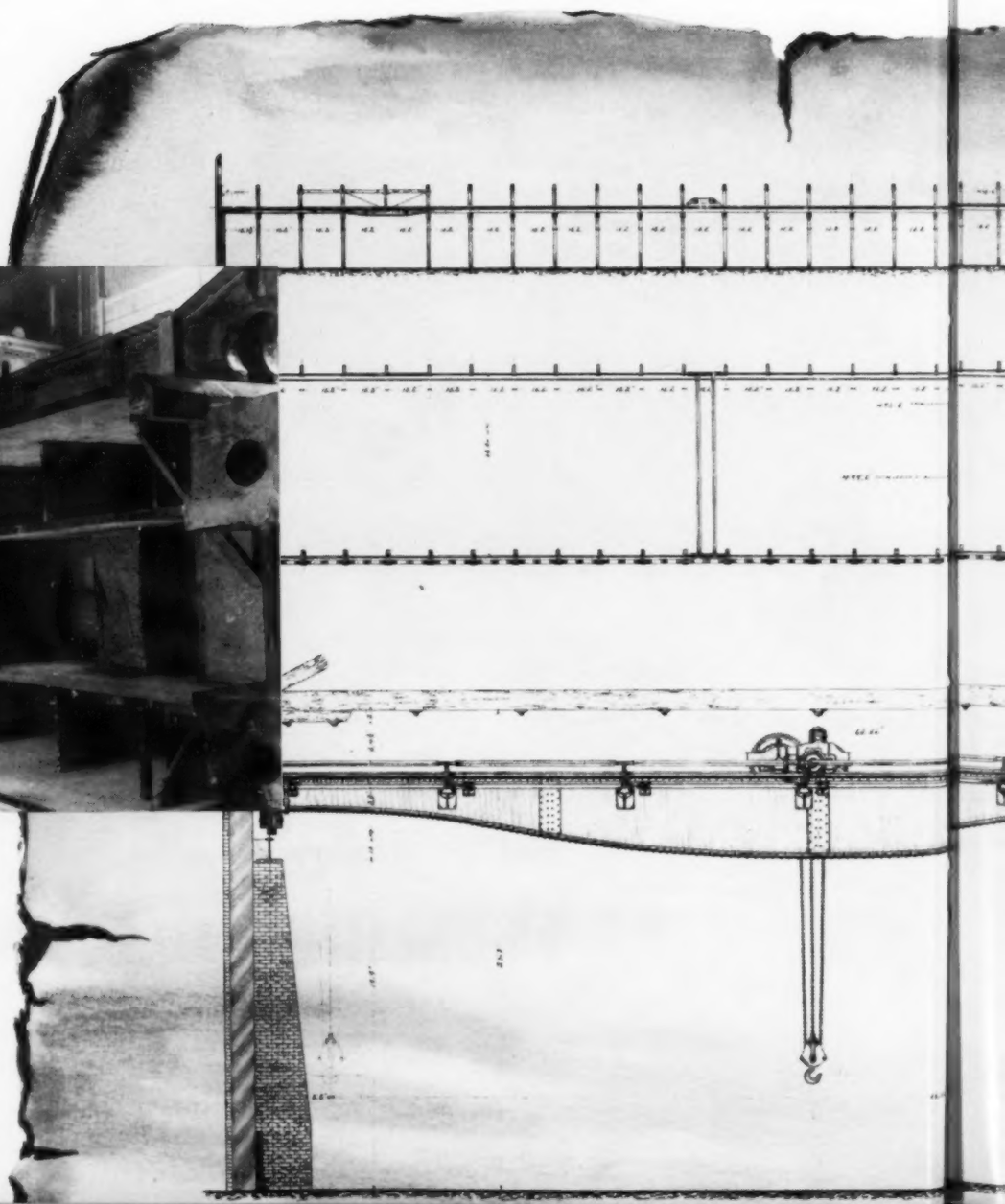
Westinghouse

For <u>real</u> savings . . . an extra measure of efficiency, safety, dependability

Morgan cranes and mill equipment



TODAY, *this 52-foot stress-relieving furnace is used to make sure that precise alignment of parts is retained in Morgan cranes and mill equipment. Minimum maintenance is assured by careful attention to details . . . a Morgan tradition.*

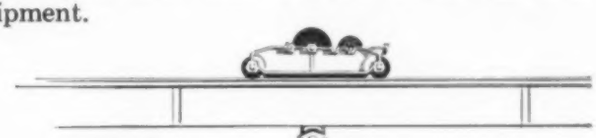


SINCE 1868, the name MORGAN has stood for advanced design and trusted craftsmanship. Close and continuous contact with industry's needs has resulted in a steady flow of improvements in Morgan cranes, mills, shears, saws, roller tables and auxiliary mill machinery.

Creative engineering, new production techniques and quality in every detail have combined to give you greater speed and capacities, lower operating and maintenance costs.

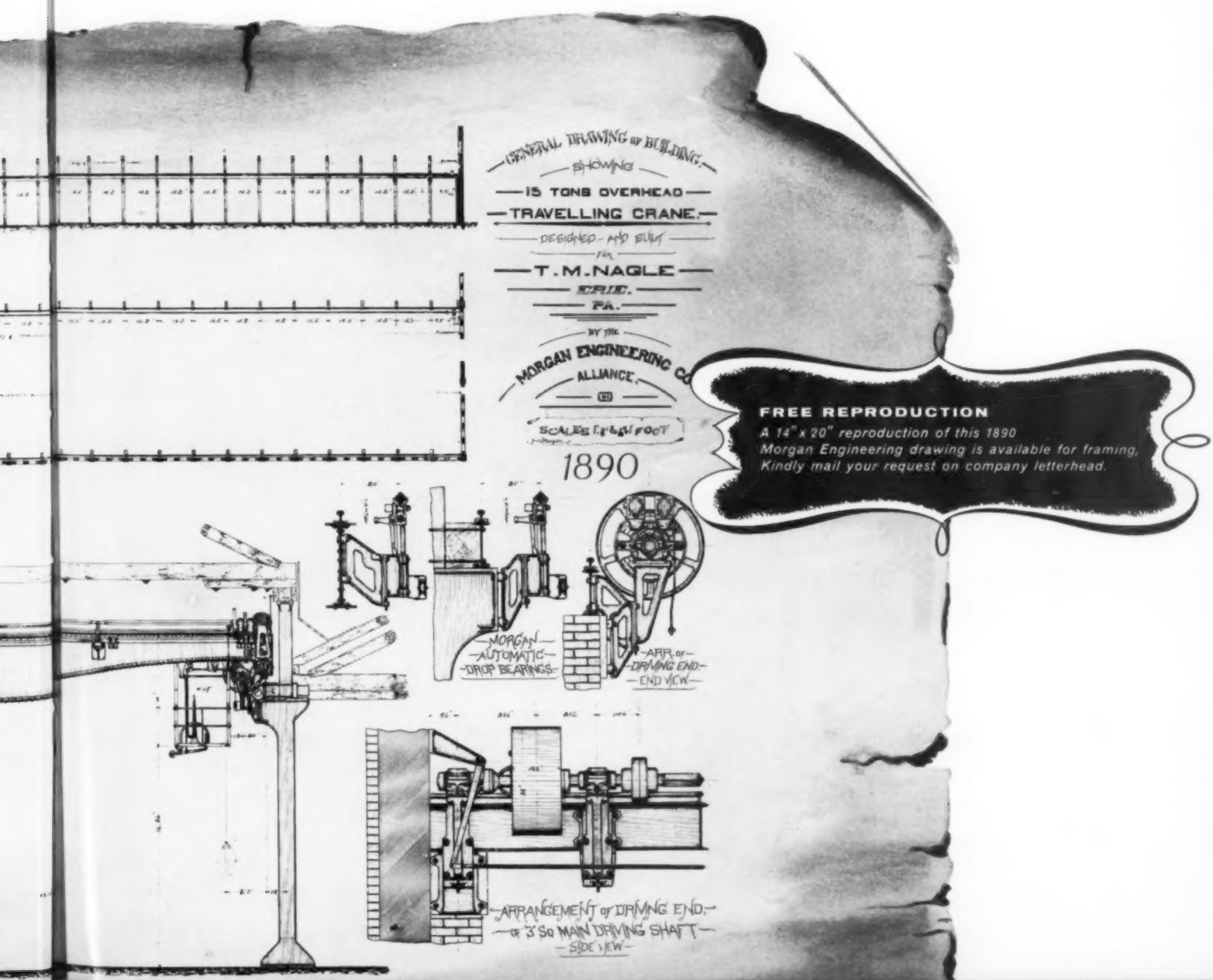
One of many production procedures used to assure the highest degree of dependability is a 20′ x 18′ x 52′ stress-relieving furnace . . . one of the largest automatically controlled installations in the world. It can raise the temperature of a 250,000 pound load 200°F per hour, up to a maximum of 1750°F. Stress-relieving assures that precise alignment of gearing shafts and other parts will be retained . . . that maintenance is held to a minimum in Morgan products.

Let our representative help you plan for *real* savings . . . longer service life, lower operating and maintenance costs with Morgan cranes and mill equipment.



THE
MORGAN
ENGINEERING CO. *Alliance, Ohio*

Overhead electric traveling cranes, gantry cranes, open hearth special cranes, plate mills, blooming mills, structural mills, shears, saws and auxiliary equipment

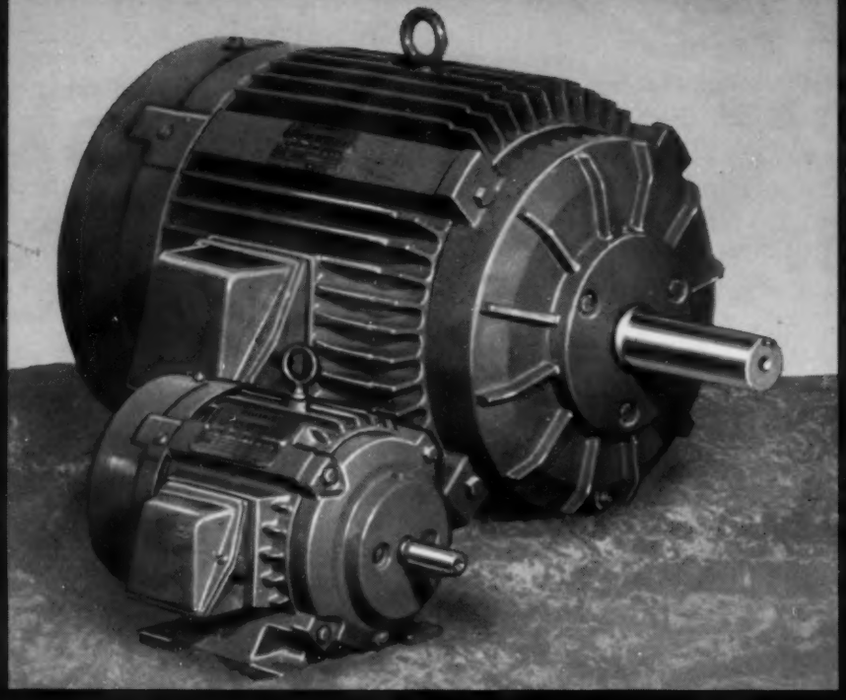


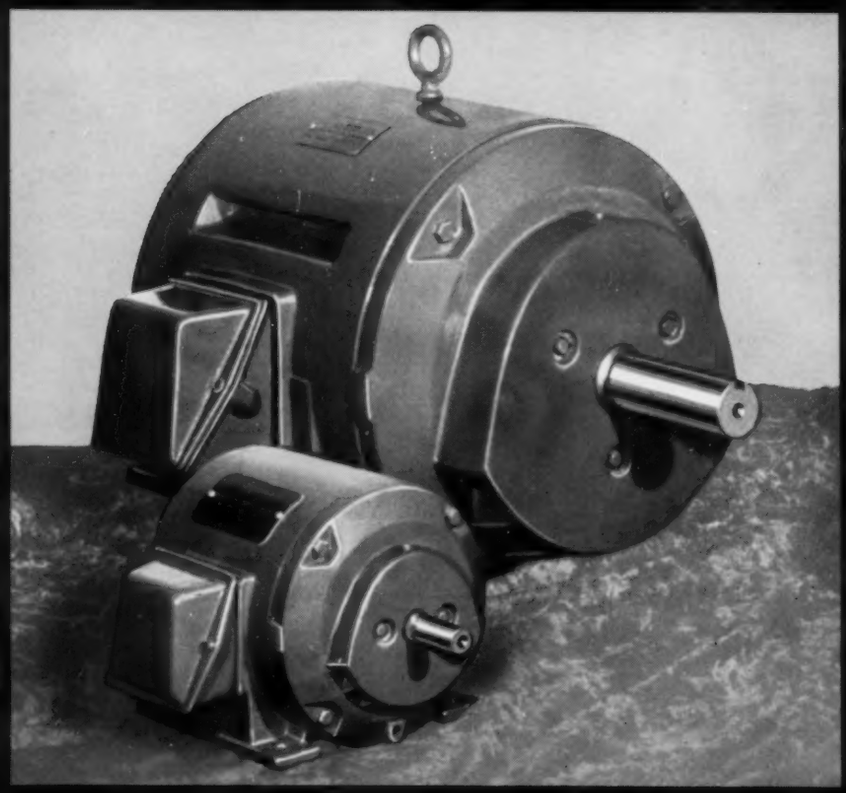
FREE REPRODUCTION

A 14" x 20" reproduction of this 1890 Morgan Engineering drawing is available for framing. Kindly mail your request on company letterhead.

RELIANCE

extends Totally Protected A-c. Motor line to 125 HP.





Reliance's proven Totally Protected design is now being extended thru 125 horsepower.

Now Totally Protected Motors will be available to you from 1 thru 125 hp. in new NEMA ratings.

Immediate delivery from stock today, 1 to 50 hp. Contact your Reliance representative for shipping schedules on other ratings. B-1573

Write or call today for further information

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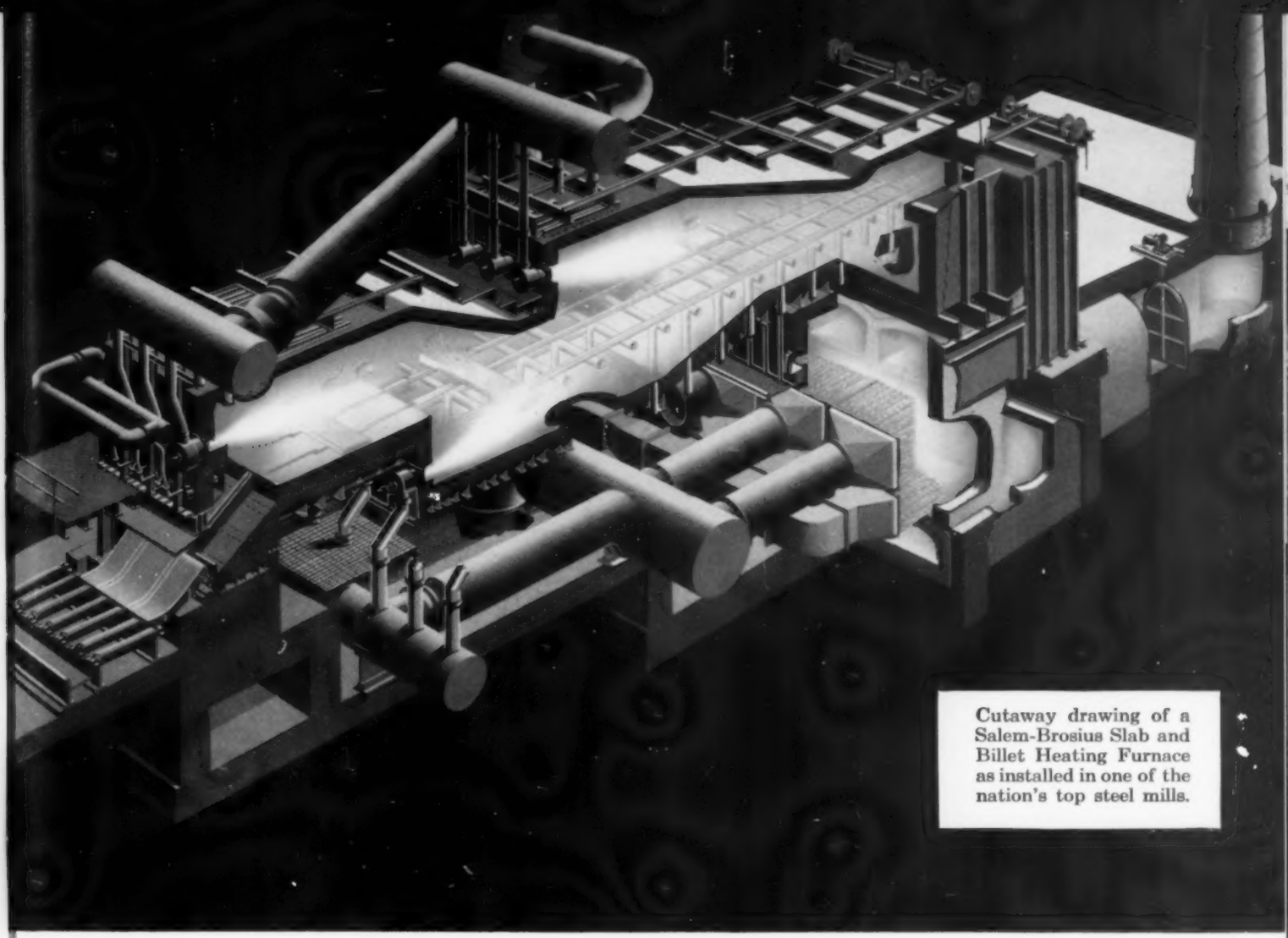

Cutaway drawing of a Salem-Brosius Slab and Billet Heating Furnace as installed in one of the nation's top steel mills.

In this Salem-Brosius furnace better steel products are born

All over the country, steel producers are turning to Salem-Brosius Pusher-Type Slab and Billet Heaters, because they have come to know that these furnaces will produce maximum tonnages of evenly heated, accurately temperatured steel at the lowest fuel consumption rate. The triple-fired furnace shown above features accurately controlled heating and soaking zones, heavy construction, recuperators for fuel economy, dual gas-oil fuel system, low maintenance cost, and many other advantages. These assure positive, automatic control of furnace output and heating quality.

And the efficiency, economy, ease-of-operation, and trouble-free service this furnace affords are typical of all the furnaces Salem-Brosius builds. Whether you require this or any other heating or heat treating furnace, Salem-Brosius offers equipment designed, engineered, and built not merely as a furnace but as a heating machine. You can purchase these furnaces as complete installations—equipped with all controls, piping and wiring—ready to operate. Write to us.

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Major Steel Producer Orders Two More Koppers Electrostatic Precipitators for Gas Cleaning

Leading Steelmaker has ordered 15 Koppers Electrostatic Precipitators since 1947

SUCCESSIVE orders over a nine-year period prove the efficiency and economy of Koppers electrostatic precipitators at the plants of one of the nation's top steel producers.

Proves Performance on the Job

This industry leader installed its first Koppers electrostatic precipitator in 1947 at a Pennsylvania plant. Additional orders followed. Koppers units now operate in the company's plants in Maryland and Pennsylvania. Two factors spurred re-orders. Koppers units were economical and efficient. Koppers engineers were able to supply a wide range of CFM capacities.

Supplies a Wide Range

These Koppers electrostatic precipitators range in capacity from 33,334 CFM to 120,000 CFM. Guaranteed efficiency runs as high as 99.2% and each Koppers unit has exceeded its guaranteed performance. Engineering know-how enables Koppers to economically satisfy each individual application.

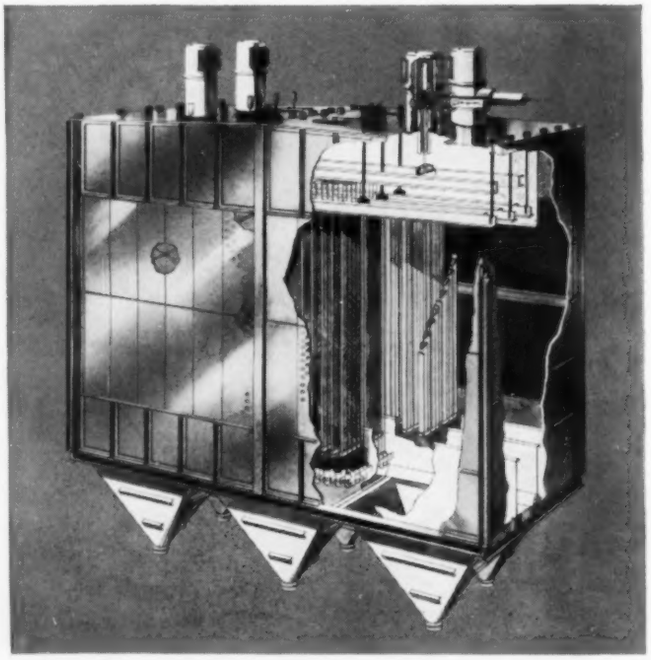
Meets Individual Plant Needs

Koppers custom-designs each electrostatic precipitator for its particular application. It may be at a blast furnace or an open hearth furnace, using either hot or cold metal process. It may be for hot scarfing or detarring coke gases. Whatever the job, Koppers provides highly effective gas cleaning at low cost per foot of gas processed.

Backed by Know-How

Koppers has over 75 years' experience in industrial gas cleaning. In addition, Koppers maintains extensive research facilities at Verona, Pa., and Baltimore, Md. Manufacturing facilities at Baltimore produce a complete line of gas cleaning equipment for every size and type of plant.

You can put all of this experience and equipment to work solving your gas cleaning problem. Just write KOPPERS COMPANY, INC., Metal Products Division, Industrial Gas Cleaning Dept., 8312 Scott Street, Baltimore 3, Maryland.



Cutaway photo of a Koppers electrostatic precipitator shows shell, vibrators, and collecting and discharge electrodes. The actual design and arrangement of elements vary widely because Koppers electrostatic precipitators are custom-designed to fit the requirements of each particular application.

Do you worry about the cost of wiring that new power distribution system

ON A SUNDAY AFTERNOON?

Sure, new power systems cost plenty — and it takes close figuring to get maximum results at reasonable prices. But you don't have to worry about getting dependable wiring at the right price — an armored cable and rack system using Rockbestos A.V.C.* Interlocked Armored Cable is your best solution. Here's why:

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*A.V.C.-Asbestos, varnished cambric insulated. Single conductors are standard N.E.C. Type AVA power cables.

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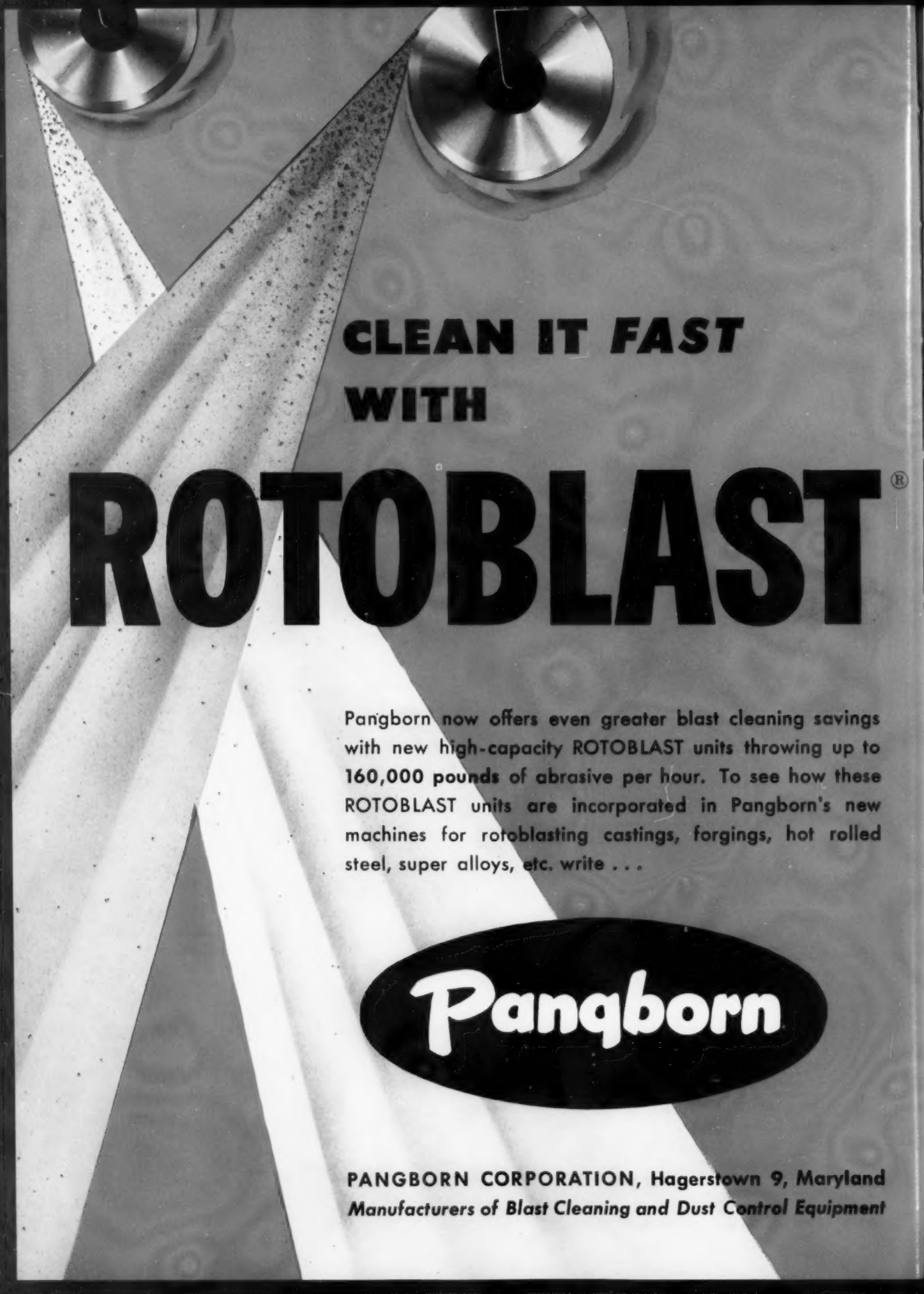
For New Buildings, Expanding Existing Circuits, Relocating Old Circuits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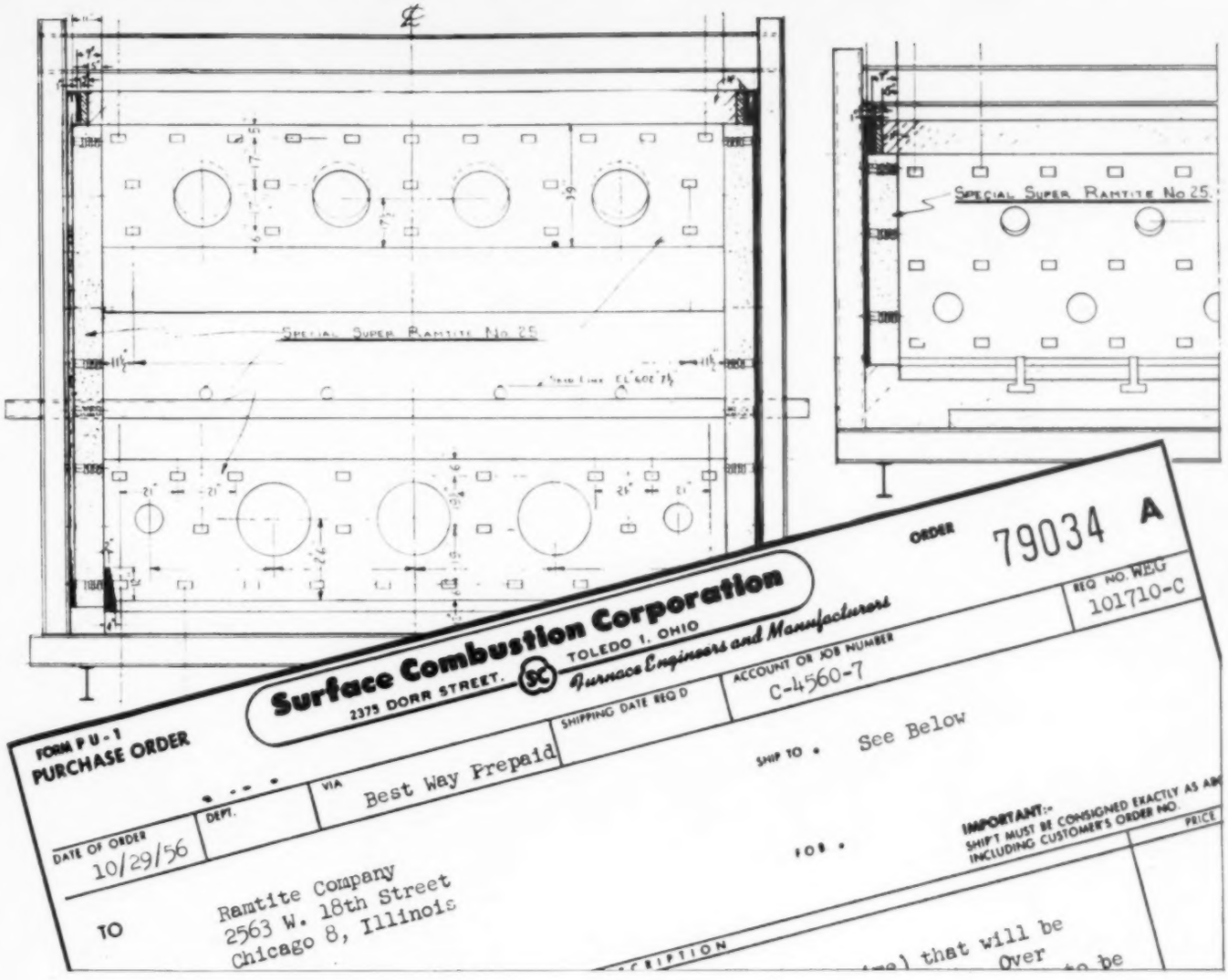

Four more NEW Surface® slab heating furnaces with RAMTITE® side and burner walls

In slab heating furnaces as in other steel mill applications, it's performance that counts. We feel that is the reason for the ever increasing use of Ramtite by steel mills and furnace designers throughout the nation—and for the above purchase order for Ramtite to line the side and burner walls in these new 135 ton triple fired furnaces.

Ramtite performance in similar furnaces has resulted in:

1. ***Increased furnace capacity***—high thermal efficiency permits a 25% to 30% reduction in thickness over standard wall construction.

2. ***Fuel savings***—monolithic construction eliminates joints, reduces air and gas leakage as never before.

3. ***Low maintenance***—inherent spall resistance assures longer refractory life.

The Ramtite Co. offers you a complete sales engineering service—experienced men who are always available to study your refractory problems and consult with your engineering, mason and ceramic departments about your specific needs.

For further information, contact your local Ramtite representative.

Ramtite is our business . . . not a sideline

The Ramtite Co.

DIV. OF THE S. OBERMAYER CO.

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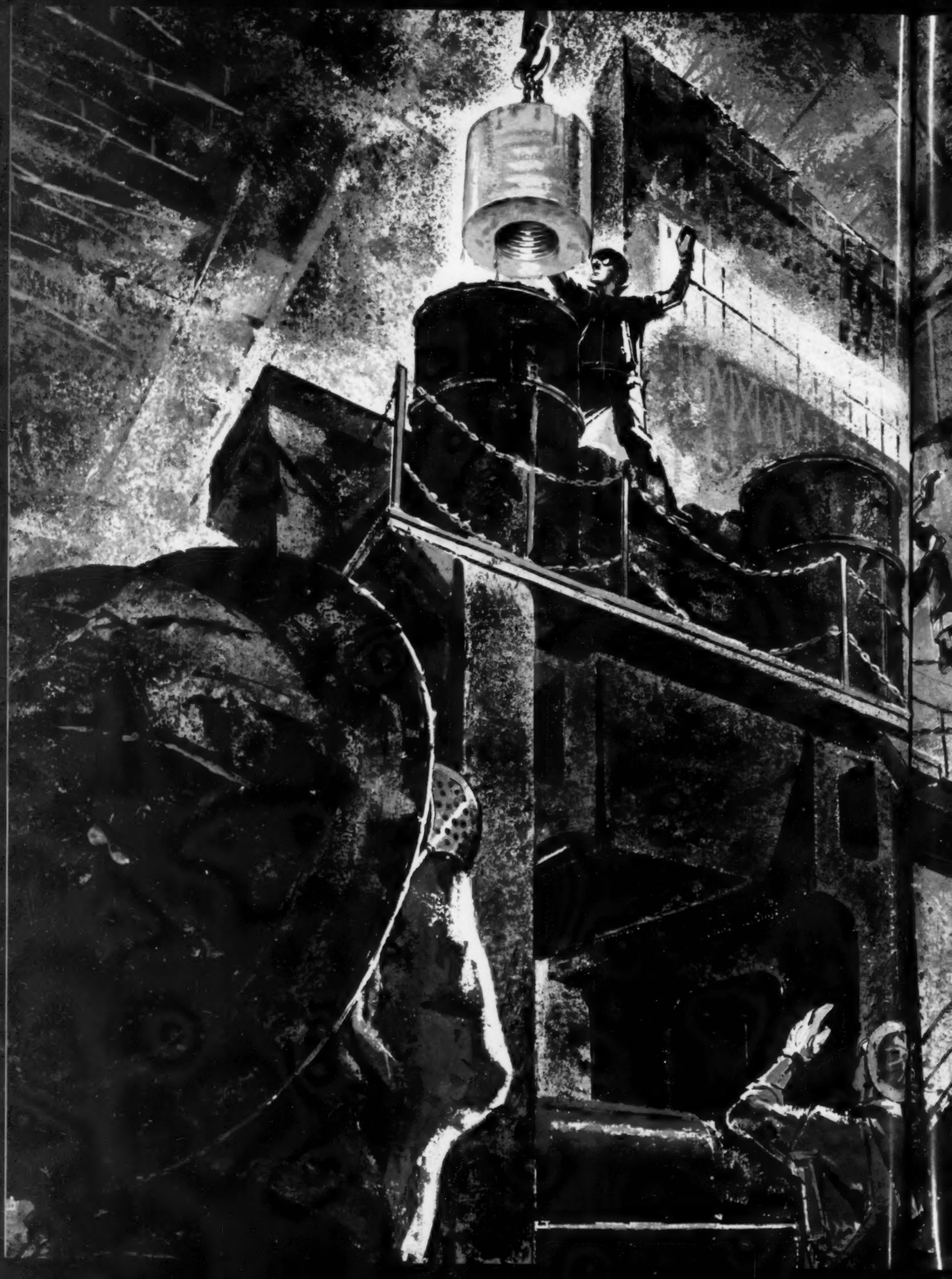
This is another in a series of advertisements depicting ways Ramtite Refractories serve the steel industry.



NBD screw nut works 3¼ million tons of steel

Proves value of NBD centrifugal casting for adding extra service life

AFTER working fantastic tonnage . . . 3,266,599 tons to be exact . . . on a universal slabbing mill at United States Steel's Homestead Works, this NBD screw nut was finally replaced as one of a pair. (About 6 months' service life still remained in this nut.)

How can bronze be so tough? NBD makes it that way . . . in the casting, the alloy, the machining accuracy.

Instead of sand casting, we use special centrifugal casting techniques for screw nuts. We get a denser, sounder, higher strength casting . . . with a longer pay-off in rugged steel mill service.

Our centrifugal equipment handles casting weights up to 10,000 lbs.

The only other secret is the bronze alloy we use, and this is where 80 years in the bronze and copper business pays a bonus. We've discovered screw nut alloys that are not only tough enough to take terrific punishment, but are easy on forged steel screws. (The screw used with the nut above is still working, good for another three million tons, as wear to it was negligible.)

NBD precision-machines everything but the screw nut thread, a specialty job for which we have an excellent source.

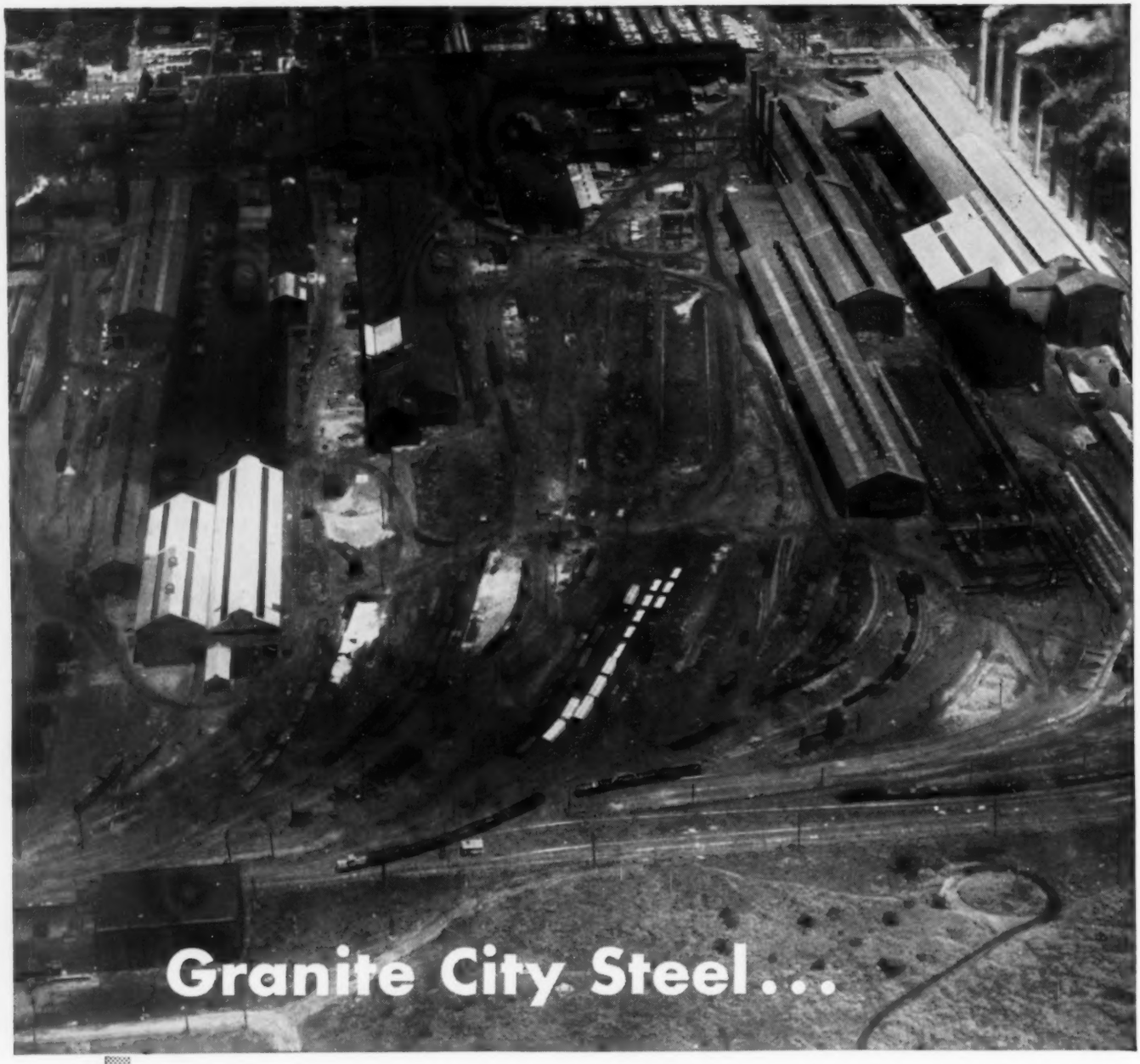
Call us to talk about screw nuts, stripper nuts, housing nuts—or any other parts in our complete line of steel mill bronze and copper (high conductivity included).

compare your screw nut service with these facts:

Installed: April 6, 1954; replaced February 27, 1956
Finished weight of nut: 7085 lbs.
Screw speed: 17.3 feet/min.
Pressure on screw: 200,000 lbs.
Mill speed: 80 to 120 RPM.
Ingot sizes: from 29″ x 66″ x 110″ to 39″ x 72″ x 105″
Ingot weights: from 47,350 to 74,070 lbs.
Rolled thicknesses: from 3″ to 21″ with max. 66″ widths
Rolling temperature: approximately 2300°F
Principal grades of steel rolled: Std. Open Hearth, Stainless, Manganese, Corten
Total tonnage steel rolled: 3,266,599

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION
717 Grant Building · Pittsburgh 19, Pennsylvania
PLANTS IN: CHICAGO · ST. LOUIS · MEADVILLE, PA.



Where new "tonnage" oxygen generator will augment units with 7 years successful operation

"On-location" generators—designed and erected by Air Products, Incorporated—are producing 8,500,000 cu.ft./mo. of high purity oxygen for Granite City Steel Company. An additional generator is now being installed, and will bring this mill's oxygen capacity up to 57,500,000 cu.ft./mo.

Since 1950, this high purity oxygen has reduced steel making costs by meeting a continuous demand for such operations as welding, cutting and hand scarfing. The new equipment will produce oxygen for use in open hearths . . . shortening the heat time and thus increasing open hearth capacity.

Many steel companies obtain low-cost oxygen from dependable Air Products generators in many combinations of quantity, purity and pressure.

We produce: package, tonnage and custom-built oxygen and nitrogen generators. Let us tell you how you can get dependable, continuous supply of low-cost oxygen. Air Products, Incorporated, P.O. Box 538, Allentown, Pa.

Air Products
...INCORPORATED

J & L finds a thrifty way to equip a mill with new downcoilers

Not long ago, the 96" hot strip mill at Jones & Laughlin's Pittsburgh Works began to show need for coiler improvements. Bliss Rolling Mill engineers were called in to see what could be done.

After analyzing the situation, they determined that parts of the existing coilers could be retained for use with the Bliss Downcoiler principle. Bliss then performed the task of special design and "field tailoring" to insure improved functional operation.

Today, J & L has the equivalent of a pair of brand new downcoilers, complete with new housings, blocker rolls, stripper mechanisms, roller tables, guides and pinch roll units. The new coilers can handle 30,000 pound coils up to 94" wide.

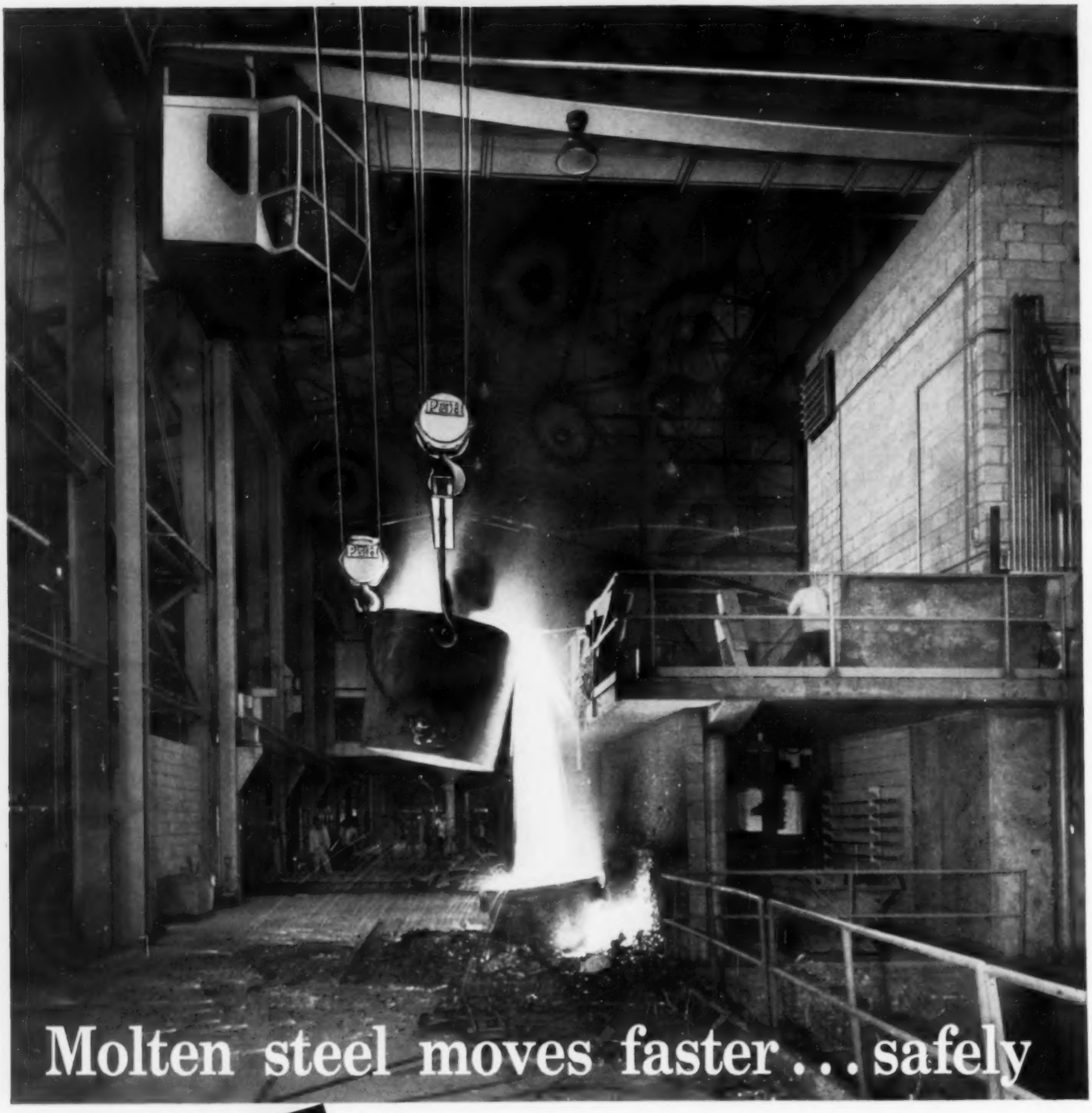
This particular installation is typical of the Bliss Rolling Mill Division's versatility and open-minded approach to a customer's problem. It's easy to learn more about what they have done and can do... just write us today for a free copy of our 84-page Rolling Mill Brochure, Bulletin 40-B.

BLISS
SINCE 1857

100 years of making metal work for mankind

E. W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio



with P&H Electronic Crane Control

From furnace to casting pit, loads of molten steel glide through the air with the greatest of ease and safety — and they can be spotted on a dime, when handled with P&H electronically-controlled overhead cranes. P&H electronic control furnishes "stepless" response for infinitely variable, more precise crane operation.

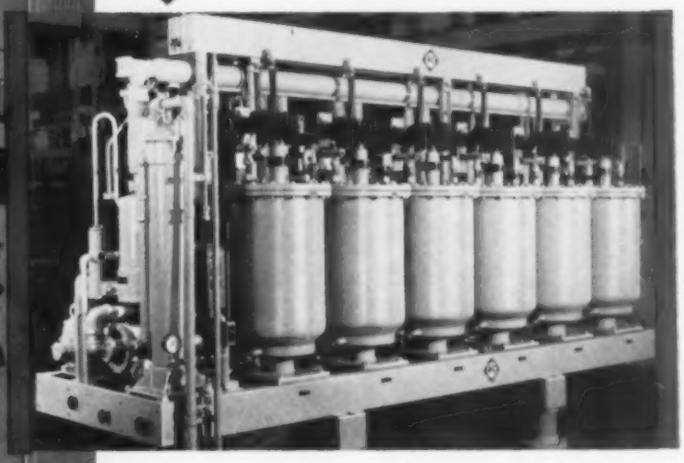
A flip of the lever enables the operator to pinpoint a charge bucket into the furnace . . . to synchronize ladle positioning for tapping the heat. With the same ease, he can control the auxiliary hoist during slagging-off, then speed the molten steel to the casting pit without incident or accident.

Find out how P&H electronic crane control can speed your production and slash crane maintenance. Write Dept.125G,Harnischfeger Corp., Milwaukee 46, Wisconsin.

HARNISCHFEGER

P&H . . . quality and service for 73 years

Open pumped tube unit permits easy access for inspection. Easy to recondition in field.



Enclosed sealed tube unit conserves space, cuts installation costs, eliminates need for vacuum pumping system.

ALLIS-CHALMERS

Mercury Arc Rectifiers

Pumped or Sealed? Open or Enclosed?

Here's how Allis-Chalmers can help you choose a rectifier for your job—

BOTH sealed and pump-evacuated tube rectifiers offer distinct advantages, depending upon the application. Whether your rectifier should be open or enclosed construction also depends on the application. Since Allis-Chalmers offers you a choice of sealed or pumped tubes in either open or enclosed construction, you get an unbiased recommendation, based on a study of your needs, and not on commercial expediency. And you can be sure of unsurpassed reliability and ease of operation, as proved in hundreds of Allis-Chalmers installations.

Only Allis-Chalmers Excitron Rectifiers give you all these important advantages—

- **Fixed excitation anode** does not contact mercury — is independent of level, turbulence or impurities.
- **Continuous excitation** eliminates need for reignition — pilot arc always present.
- **Grid phase control** located in clean region near anode where ion density is lowest.
- **Internal cooling system** provides high heat transfer with seamless tube coil.
- **Arc-over-free tube** eliminates arc-over danger by insulating entire arc path.
- **Enameled anode seals** provide high strength, trouble-free seal.

For detailed information on mercury arc rectifiers contact your nearest A-C office, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin, for bulletin 12B8494.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5560

HAGAN CONTROL helps

Flexibility of Hagan control system permits solution of ingot heating problem at Crucible Steel's Midland Plant.

Faced with the need for better circulation at low fuel input, Crucible's engineers adjusted the Hagan Fuel-Air regulator so that it was biased to produce automatically an accurately measured dilution of the gas-air mixture at low flows (from 106% theoretical air during the heating period to 215% theoretical air during the soaking period). No scale problem was encountered.

This gave the effect of firing a low Btu gas and achieved the desired uniformity of heat distribution. Tons per hour increased, and Btu's per ton decreased.

The engineers were very satisfied with the results achieved by this change, and made the comment, "We were fortunate in having a control flexible enough to do this."

Hagan control components are built with this particular objective in mind. Every unit is designed to offer engineers wide latitude not only in application, but also in performance. Hagan instruments and controls are dependable, extremely accurate and versatile. Why not discuss your control and instrumentation problems with the Hagan engineer. He can help you find a solution.

solve a soaking pit problem

NOTES ON THE HAGAN INSTALLATION AT CRUCIBLE STEEL'S MIDLAND PLANT.

Fuel-Air Ratio Control

A high degree of accuracy is achieved in this part of the Hagan soaking pit control. In normal operation, a double diaphragm regulator controls the ratio by pneumatically repositioning the combustion air valve. This normal operation can be varied by moving the fulcrum of the ratio regulator. This is provided by:

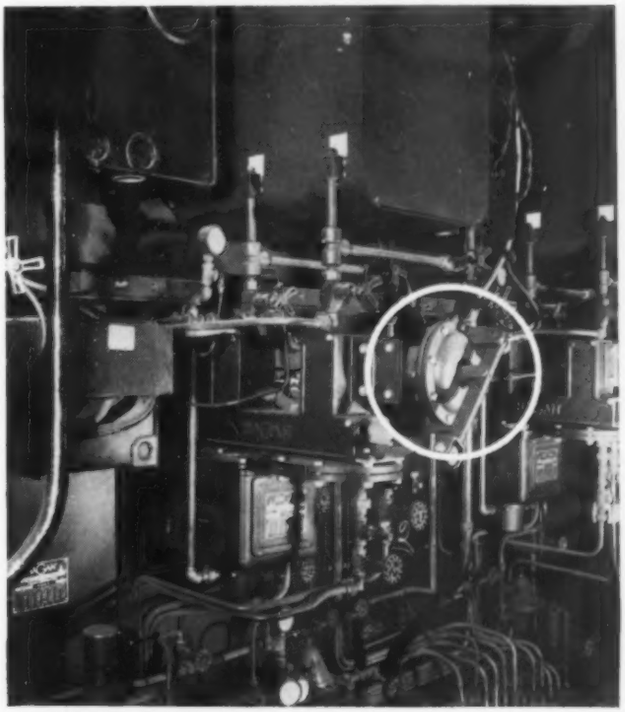
Combustion Air Temperature Compensation

By means of an air temperature transmitter, connected to a thermocouple in the hot air duct, a pneumatic signal is transmitted to a diaphragm operator. This operator serves as a fulcrum positioner for the fuel-air ratio regulator, so that the ratio is maintained despite variations in combustion air temperature.

Hagan control systems are also used for collector flue draft control, pit pressure measurement, recuperator temperature control and measurement and for the safety systems. These various parts of the overall system are functioning accurately and dependably, and actual records show extremely low maintenance costs. To quote the Crucible engineers again, "Considering the types of steel being heated, controlled-heating cycles required, and track times, we believe the pits are doing an excellent job."

Reprints of an article, "Problems of a New Soaking Pit Installation" are available. Write for your copy.

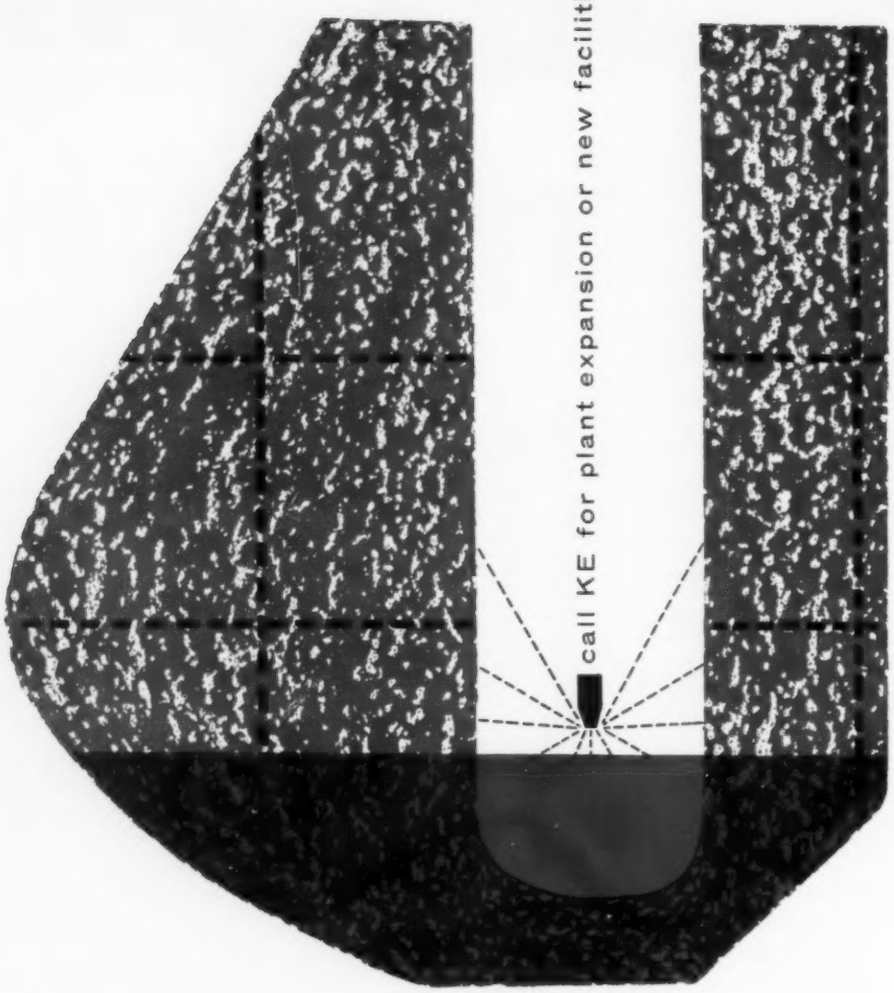
Control panel for Crucible Soaking Pits.



Back of panel, showing double diaphragm fuel-air ratio control and (in circle) the temperature compensating fulcrum positioner.

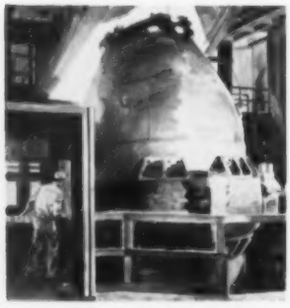
HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED
OFFICES IN: MONTREAL, TORONTO, VANCOUVER, EDMONTON



INGENUITY

has made KE the experienced leader in L-D Process Steel



L-D process plant similar to that now being installed by KE at a major eastern steel plant.

Design and construction of over 2,000,000 tons of oxygen steel making capacity. Intimate familiarity with oxygen steel technology in all parts of the world. A pioneer's experience in applying tested techniques of steel making. U.S. licensor for the proven L-D process—also P.T. Oxygen Guns for present and planned open hearths.

These are reasons why Kaiser Engineers is uniquely qualified to develop your oxygen steel program. Another reason is traditional KE ingenuity—engineering and construction ingenuity which means your steel facilities will be completed more quickly, at lower cost, and operate more efficiently.

Economic analysis, plant location, engineering, design, procurement, expediting, construction—KE does one or all. With your first thought of new steel producing facilities—call KE.

KAISER ENGINEERS

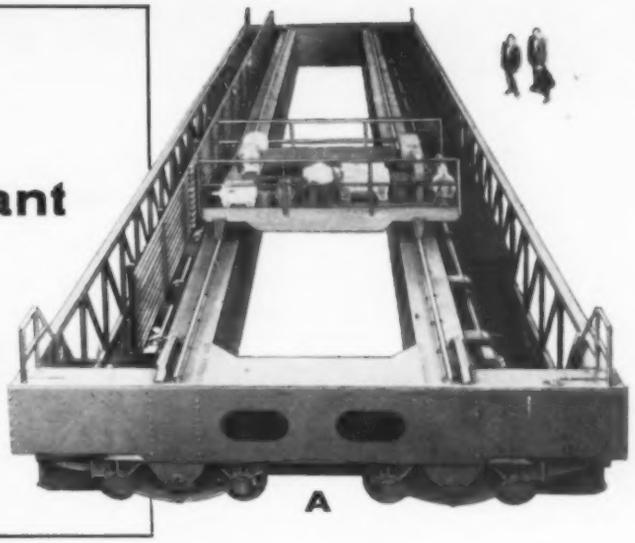
engineers—contractors

Contracting since 1914

Division of Henry J. Kaiser Company • Oakland 12, California • New York, Pittsburgh, Washington, D.C., Buenos Aires, Calcutta, Dusseldorf, Montreal, Rio de Janeiro, Sydney, Tokyo

4381

Get the Crane You Want
. . . turn to
SHAW-BOX



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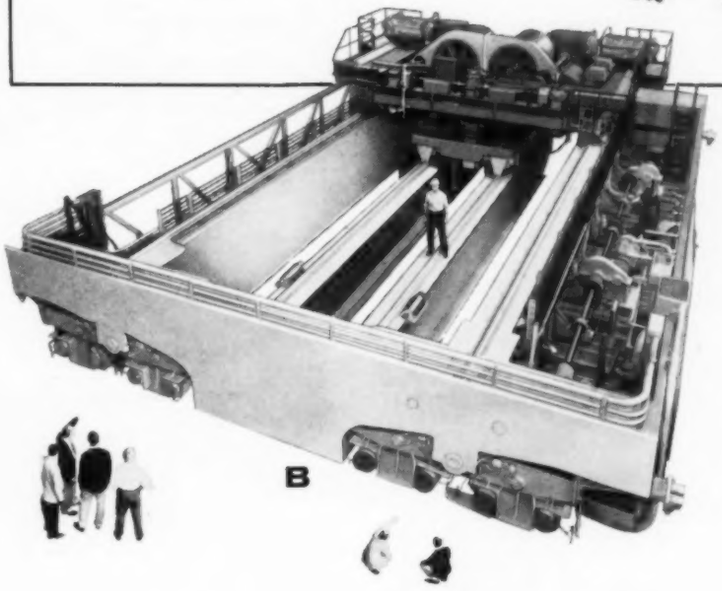
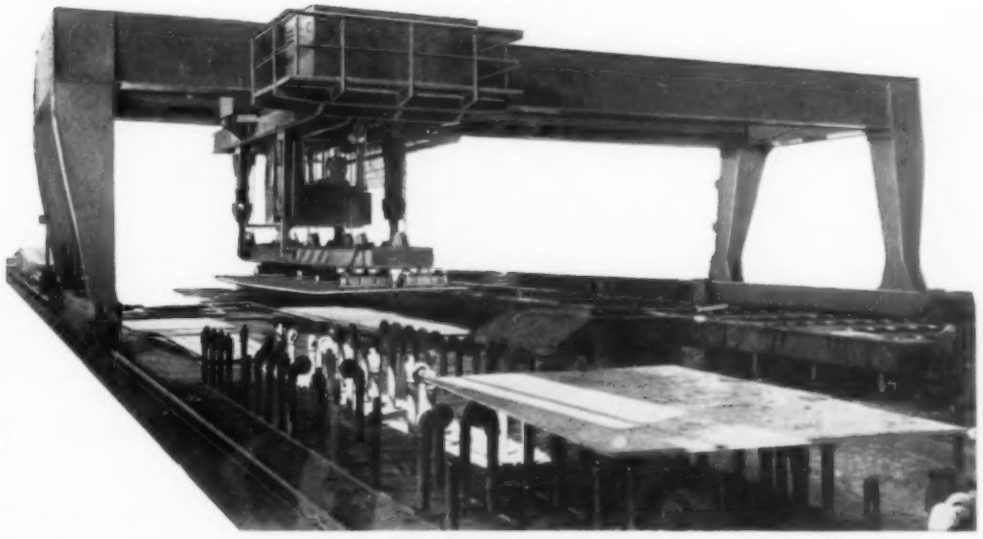


B

"Shaw-Box" Cranes are built exactly to specifications — your own or AISE Standard Specifications No. 6. Whether your plans call for a plate or slab handling crane, a soaking pit carriage, or a ladle crane, the long experience and vast facilities of Shaw-Box can save you time, trouble and money.

Make sure your next mill crane has the strength and rugged construction essential for 'round the clock service — plus economical operation. One of our engineers will gladly discuss specifications and tell you of our standard AISE designs for 15 to 200-ton cranes. Your inquiry is invited.



C

The pictures:
(A) *25-ton, 100-foot span mill crane.* **(B)** *Ladle crane that handles 200 tons of molten steel in 90-ton ladle.* **(C)** *Plate handling gantry with lifting magnets. All have exclusive Shaw-Box structural, mechanical and operational advantages that assure reliable performance.*

57K-2

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

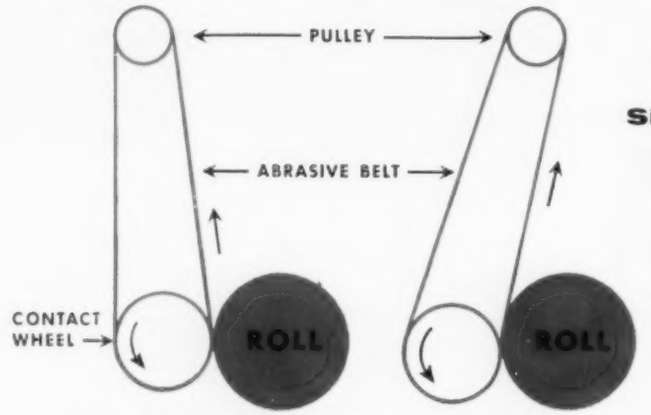
"Shaw-Box" ® CRANES

MANNING, MAXWELL & MOORE, INC.
SHAW-BOX CRANE & HOIST DIVISION
388 West Broadway • Muskegon, Michigan

Builders of "SHAW-BOX" and 'LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Other Divisions produce 'ASHCROFT' Gauges, 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments, and Aircraft Products.
In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Avenue Road, Galt, Ontario.*

CARBORUNDUM'S EXCLUSIVE ABRASIVE BELT METHODS

Reduce roll grinding and polishing time 50% to 80%



GRINDING AND FINISHING
Contact Wheel and Belt

FINE FINISHING
Slack of Belt

Simple belt attachments provide:

- Highest quality accuracy and finishes
- Stock removal rates exceeding all other methods
- Quick adaptability to standard grinding equipment

HERE'S PROOF

Typical grinding savings with abrasive belts

ON METAL ROLLS

Carborundum Installation No. 173

Carl G. Wiklander Company, Chicago, Illinois

- ROLL TYPE: Mild Steel Rotogravure Cylinder
- ROLL SIZE: 17.030" dia. x 152"
- Tolerance: ±.002"

Previous method required 13 to 15 hours to grind cylinder. Curtis RG2 and abrasive belts accomplish same job in 6 hours—*more than 50 per cent reduction in grinding time.*

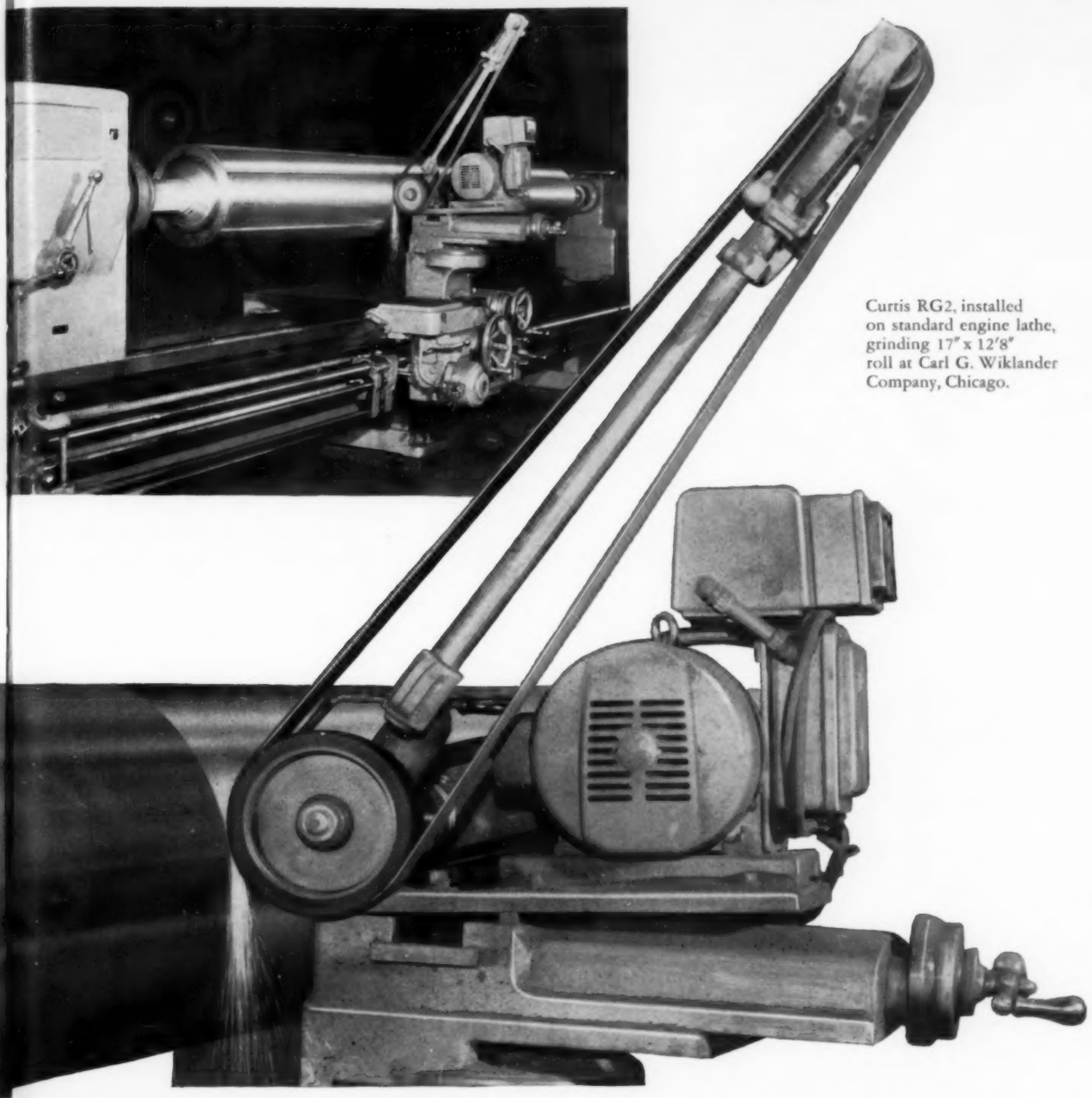
ON RUBBER ROLLS

Carborundum Installation No. 87

Passaic Rubber Company, Clifton, New Jersey

This Company recovers and finishes all types of rubber rolls with varying durometers. Employing a Curtis RG2 roll grinding attachment, the following results are being obtained:

1. Grinding time reduced 80 per cent—belt removes up to 5/16" stock per single pass.
2. Finishes *better* then with previous method.
3. Tolerances: Concentricity .001, size .002 and taper .002.
4. Elimination of hand operations with slack of belt finishing.



Curtis RG2, installed on standard engine lathe, grinding 17″ x 12′8″ roll at Carl G. Wiklander Company, Chicago.

Substantial savings can *now* be realized in roll grinding operations with *abrasive belts.* The Carborundum Company after years of laboratory experiments and one full year of in-the-plant field tests, has proved conclusively that abrasive belt roll grinding is faster, equally or more accurate than any other method and produces unprecedented economies.

Carborundum's Coated Abrasive and Curtis Machine Divisions have developed abrasive belt attachments for standard roll grinding machines and also for engine lathe operations. The engineered and regular production application of these attachments has provided the following results: 50-80 per cent time savings on grinding and polishing steel, cast iron, brass, aluminum, copper and stainless rolls while maintaining the most exacting tolerances specified for all standard or special rolls; reduced labor and overhead costs; plus appreciable production savings with reduced downtime.

These abrasive belt roll grinding techniques have proved equally successful on rubber rolls of all durometers producing superior finishes without tear-out marks. Copper electric motor commutators are now also belt ground in less than half the time required in tool bit operations.

FOR SPECIFIC INFORMATION on adapting your present roll grinding equipment to abrasive belt grinding, call your Carborundum representative. He'll arrange for specialized engineering assistance. Or write, without obligation, directly to The Coated Abrasive Division, Department R.G., 2 The Carborundum Company, Niagara Falls, New York. In Canada, write to, The Canadian Carborundum Company Ltd., Department R. G.,2 Niagara Falls, Ontario.

Curtis Machines and Coated Abrasives by **CARBORUNDUM**

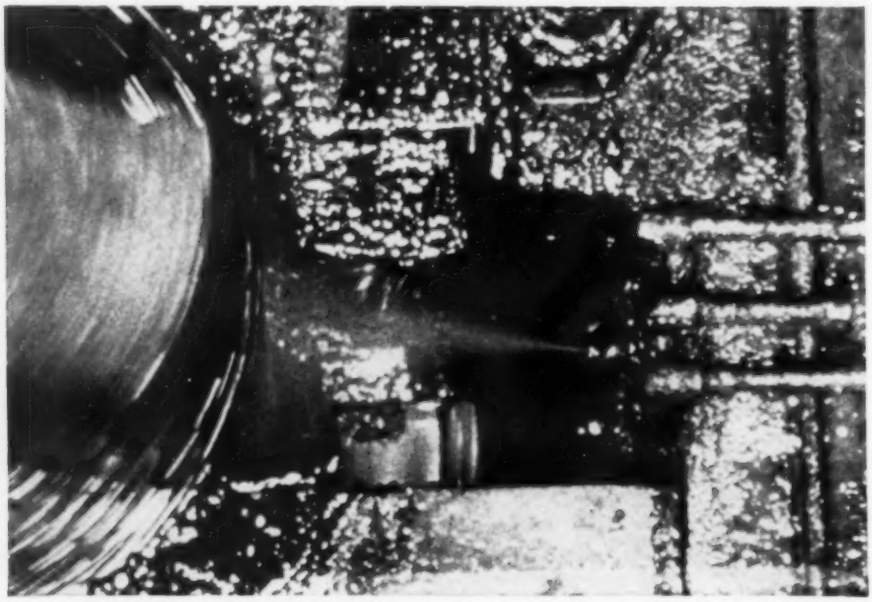
REGISTERED TRADEMARK

02-733 R

THE BROOKS OIL CO.

Lub Engineering News

A REPORT ON THE DIFFICULT LUBRICATING PROBLEMS OF INDUSTRY



SPRAY LUBRICATION OF ROLL NECK BEARINGS CUTS COSTS FIVE WAYS, STEEL MILL REPORTS

Lubrication of roll necks and bearings by means of a spray system employing a fluid lubricant, as shown in the unretouched photograph above, has proved far superior to the traditional system of forcing grease along grooves machined in the bearing surfaces, according to reports of an extended study recently completed by a major steel company.

Five major savings resulted from the use of the spray system:

1. The initial cost of preparing the bearings for service was reduced because it was not necessary to cut grease grooves. Also, the safe overall bearing area is substantially increased.
2. Lubricant consumption dropped from an average of 20 drums per week to approximately 3 drums.
3. Bearing life was substantially increased. With the old system of lubrication, bearings wore out in about 3 weeks. Bearings lubricated by the spray system showed no appreciable wear after 18 weeks of service.
4. Longer bearing and roll neck life also meant less time and cost for remachining and dressing.
5. Mill downtime was greatly reduced. With ordinary lubrication, 5 intervals of downtime would have been expected during the four months of the study period—with spray lubrication there was *no* downtime—saving thousands of dollars.

First adapted in 1949 and now being used by major steel companies for this important and severe application—the lubricant was Brook's Klingfast, a lead base fluid lubricant which retains its film strength (4 gram Timken test, 30 min. minimum—43 lbs. L.A.L.).

For complete data, write for Bulletin K-26.

NEW COLOR FILM GIVES ANSWERS TO TOUGH LUBRICATION JOBS

Want to see how good lubricants get that way—lubricants for severe industrial applications, that is?

This new 30 minute 16 mm motion picture, in full color, with sound, shows a number of tough lubrication jobs. It pictures and describes the research, manufacturing and quality control methods that enable Brooks lubricants to "stand up" under severest service.

It's available to any supervisory or engineering group interested in lubrication problems. No charge, of course—we're glad to have you see it. Just call or write any of our offices and tell them you want to borrow "The Brooks Oil Story."

HAVE YOU TRIED Klingfast® FOR OPEN GEARS?

Lubrication of open gears is one of industry's toughest jobs because of severe operating conditions in speed, vibration, shock, reversal, intermittent action, exposure to high temperature, contamination, and the added problems of inaccurate alignment, excessive clearance in bearings and incorrect contact of teeth surfaces. If you've been having open gear lubricating problems, write us about Klingfast. This lubricant has been the answer in many case studies.

BROOKS LABORATORIES ARE AT YOUR SERVICE

Extensive research is constant with Brooks. Our laboratories are available at all times, with experienced and qualified personnel to serve your lubrication research and development needs.

THE BROOKS OIL CO. 81st YEAR 1876 1957

THE BROOKS OIL COMPANY

EXECUTIVE OFFICES AND PLANT—CLEVELAND, OHIO
EXECUTIVE SALES OFFICES—928 RIDGE AVENUE, PITTSBURGH 12, PA.
OFFICES AND WAREHOUSES IN PRINCIPAL CITIES

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FURNACES

FOR EVERY INDUSTRIAL HEAT TREATING PROCESS

We specialize in designing and building production furnaces; special atmosphere generators; time and labor saving material handling and other auxiliary equipment.

EF

Fuel Fired and Electric Furnaces for processing strip, wire, tubing, stampings, castings, forgings and other ferrous and non-ferrous products in any shape or form.

1958 **1958**

JANUARY

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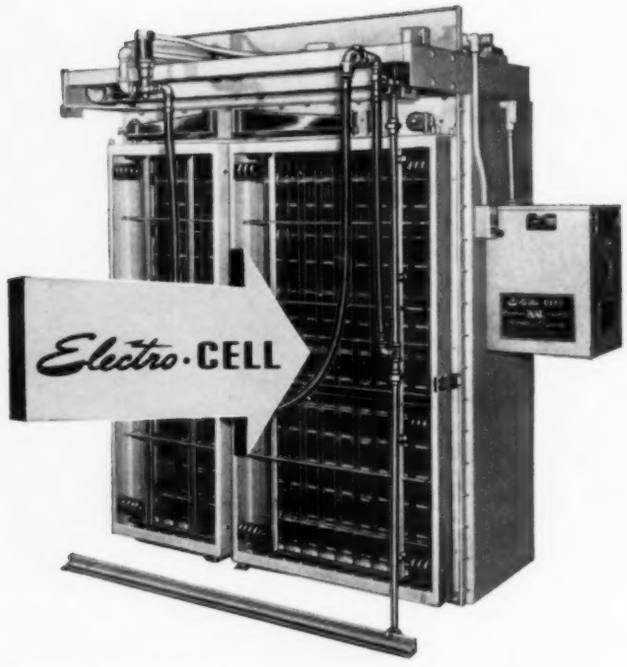
The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces — For Any Process, Product or Production

Free 1958 Calendars with Special Atmosphere Chart on back are available on 8"x11" and pocket size cards. Please advise how many you need and mention this Magazine.

AAF GIVES DUST *BOTH BARRELS!*



MULTI-DUTY gets most particles—
***Electro*·CELL stops fines and smoke!**

INDIVIDUALLY, AAF's Multi-Duty and Electro-CELL filters are time-tested veterans in providing clean air with minimum care for steel industry operations. Working together, in series, they make air *super-clean,* offer the ultimate in cleaning efficiency and maintenance-free operation.

In the "front lines" stands rough-and-ready Multi-Duty, the automatic self-cleaning viscous filter that thrives on heavy dust loads. Maintenance? Periodic removal of sludge.

Fine dust and smoke is eliminated by Electro-CELL, AAF's stationary-plate type electronic precipitator. This unit, equipped with Type H Washer, cleans its own collector plates at the push of a button. And with Multi-Duty doing the "heavy" work, the button-pushings are few and far between.

If super-clean air is your requirement, give dust both barrels—Multi-Duty and Electro-CELL. For complete information, call your local AAF representative or write direct.

AAF Filters and Precipitators

AAF Dust Control Equipment

— BETTER AIR IS OUR BUSINESS —

Herman Nelson Unit Heaters

Illinois Steam Heating Specialties

AAF herman nelson

American Air Filter
COMPANY, INC.
302 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P. Q.

IT'S EC&M FOR A COMPLETE LINE OF SYNCHRONOUS MOTOR STARTERS!

FOR ALL LOW VOLTAGES AND FOR 2200-4800 VOLT POWER SYSTEMS!

Here's Why EC&M Pushbutton Automatic Starters Do The Job Better...

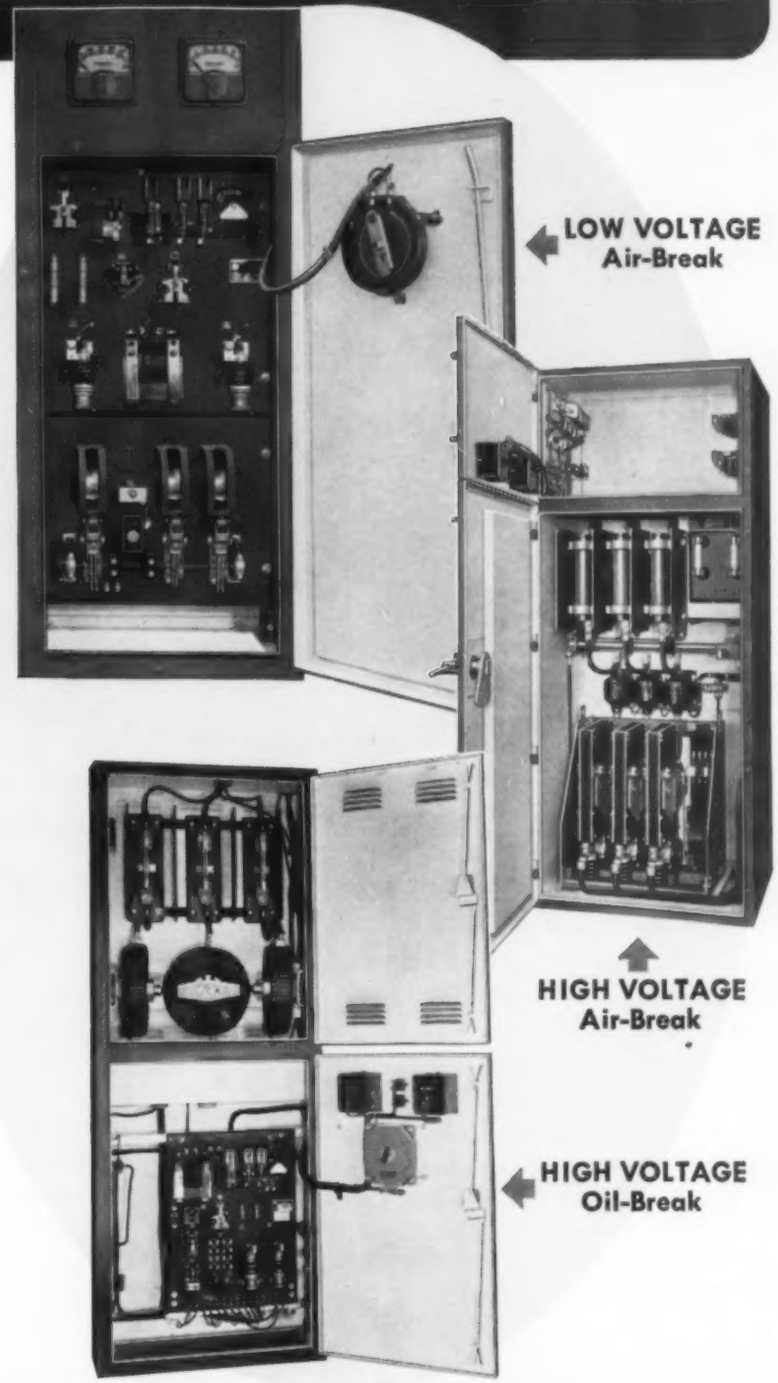
Complete protection during starting, acceleration and while running at synchronous speed.

Motor pulls into step without delay because field is applied under best conditions for synchronization.

Automatic field removal and re-synchronization allow motor to accelerate and re-synchronize after voltage dip or momentary overload.

Easily installed because all internal wiring is complete.

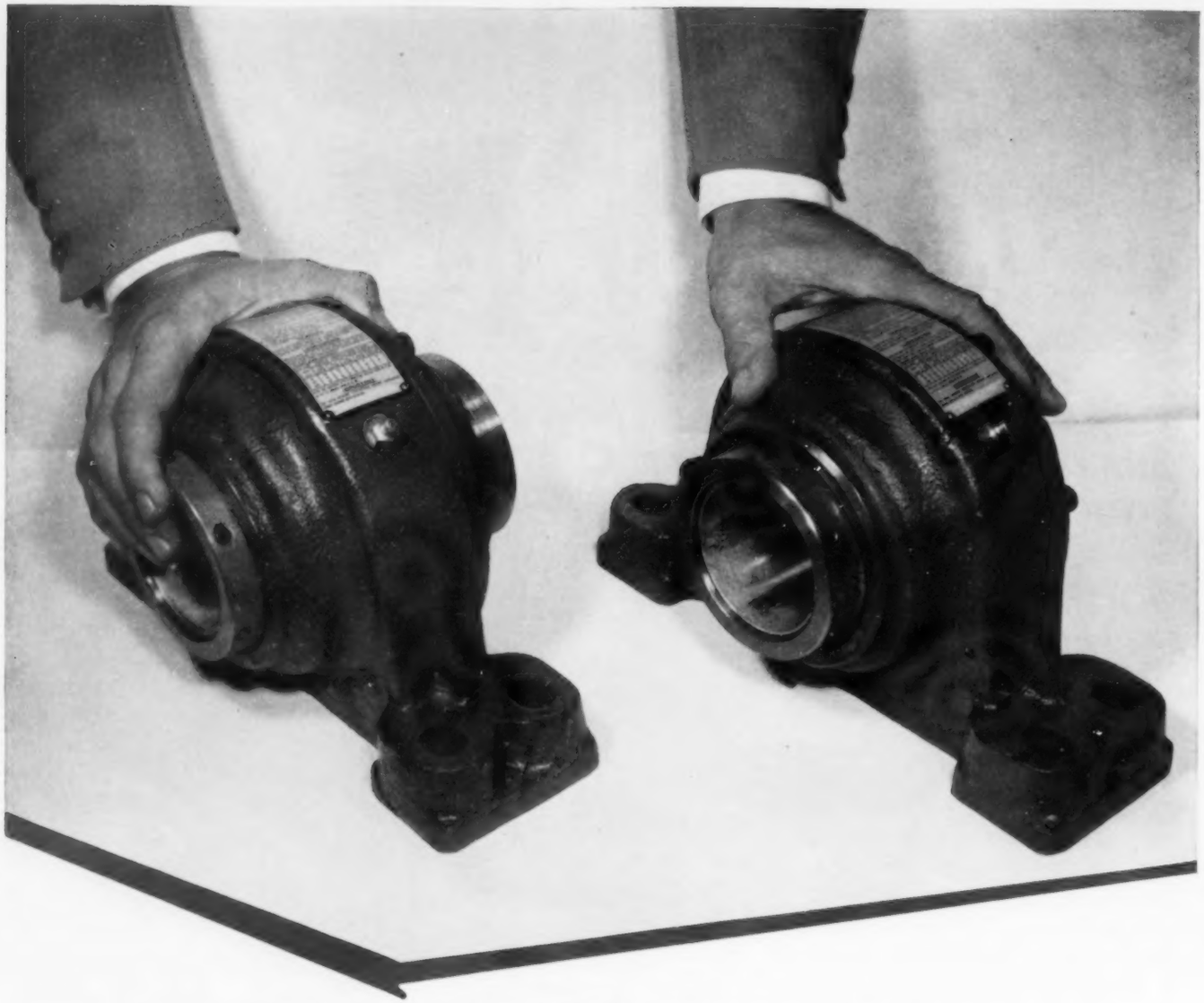
Full or reduced voltage starting All high voltage starters available in 3 ratings: (*1*) 50,000 KVA (certified) interrupting capacity—(*2*) with power-type, current-limiting fuses —(*3*) VALIMITOR® (volt-ampere-limitor), the bus may be of unlimited KVA.



Write for Bulletins 8200 and 8820

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

8587



There's a big difference in these pillow blocks . . . Bearings, Inc. knows the difference. Do you?

One of these pillow blocks contains a non-expansion or "fixed" bearing unit. The other is an expansion or "floating" bearing. Mix them up—order a "fixed" bearing where conditions dictate an expansion unit—and you are in trouble. Bearing failure in a very short time is almost certain.

One of our customers recently ordered spare bearings for new coal handling equipment and overlooked that important difference. They allowed us to check their survey of bearing requirements against the actual bearings installed on the equipment. We found on many applications "floating" units were required and their order failed to specify this vital point. Savings in time, trouble and money for our customer by this simple check were important.

Let us help *you* survey your bearing requirements—let us check the actual bearings in your equipment and we will be ready with the correct bearings you need when you need them. Call or write our branch nearest you now!

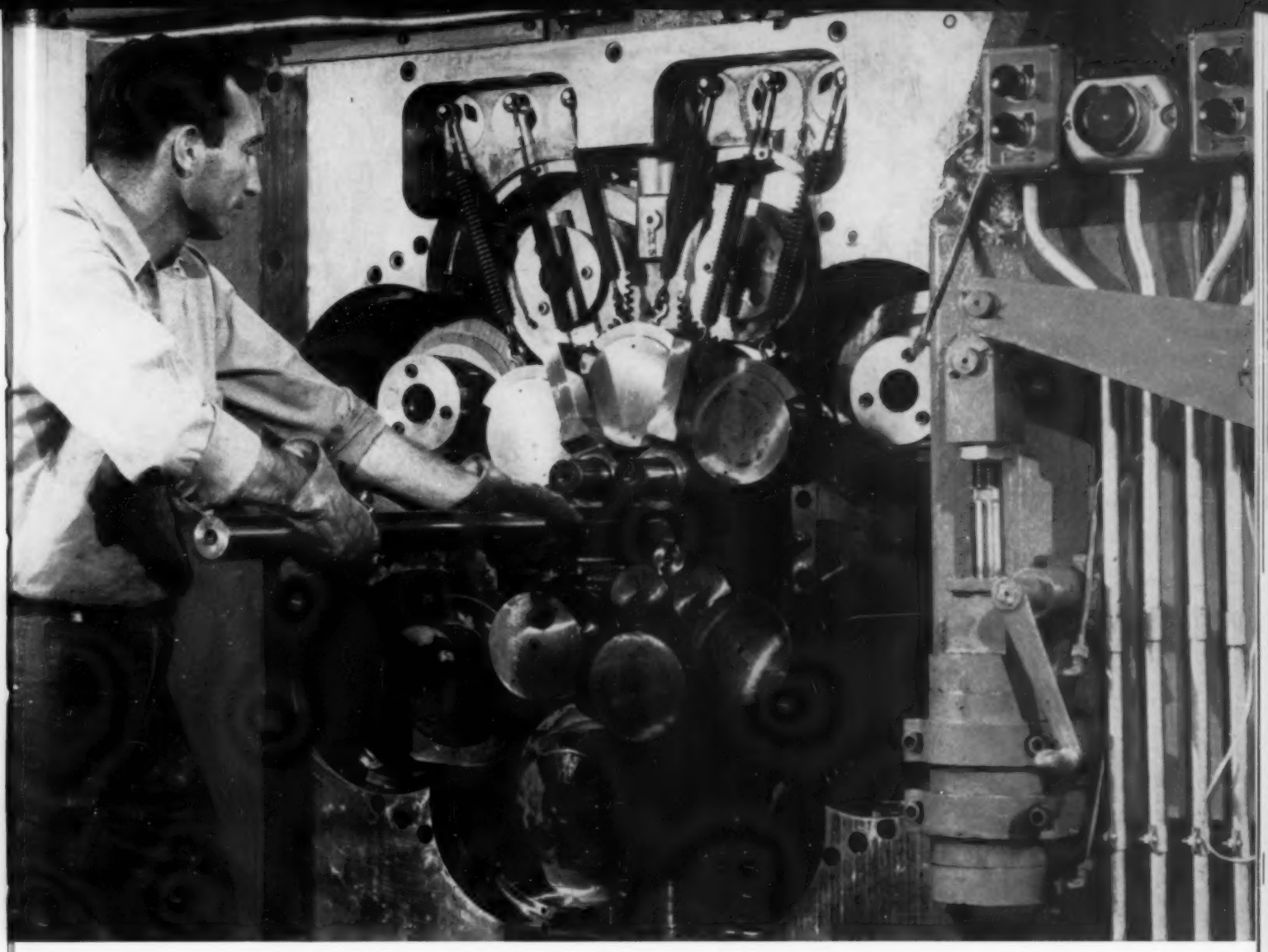
Providing bearing service in the north ➤ **BEARINGS, INC.**

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Lockland • Mansfield • Toledo • Youngstown • Zanesville
INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute • **PENNSYLVANIA:** Erie • Johnstown • Philadelphia • Pittsburgh • York
WEST VIRGINIA: Charleston • Huntington • Parkersburg • Wheeling • **NEW JERSEY:** Camden
NEW YORK: Buffalo, Balanrol Corp. • **MARYLAND:** Baltimore • **DELAWARE:** Wilmington

and

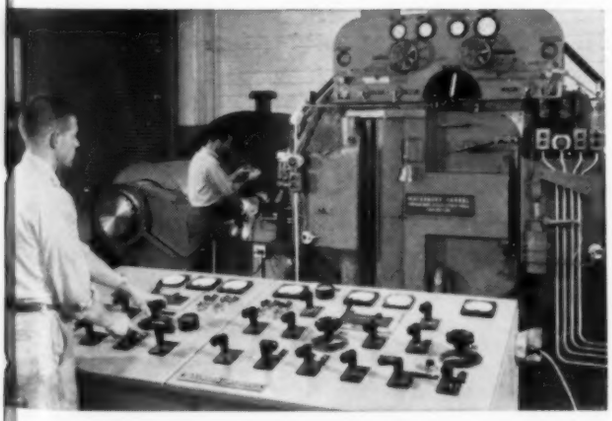
in the south ➤ **DIXIE BEARINGS** *INCORPORATED*

FLORIDA: Jacksonville • **GEORGIA:** Atlanta • **KENTUCKY:** Louisville • **LOUISIANA:** Baton Rouge • New Orleans
N. CAROLINA: Charlotte • Greensboro • **S. CAROLINA:** Greenville • **TENNESSEE:** Chattanooga • Kingsport • Knoxville • Nashville



Westinghouse drives and control help . . .

Eastern Stainless Steel Corporation increase production



Extensive experience enabled Westinghouse engineers to provide both unusual control accuracy and drive dependability required for this new 49″ Sendzimir mill. The new mill demanded drives and control for high versatility and watch-like precision to produce a wider range of light-gauge stainless steel.

The reel motors are supplied by individual generators and are accurately controlled by Westinghouse Magamp* regulators for speeds up to 700 ft./min. Power is supplied by a 3125-kw M-G set to motors which total 3750 hp.

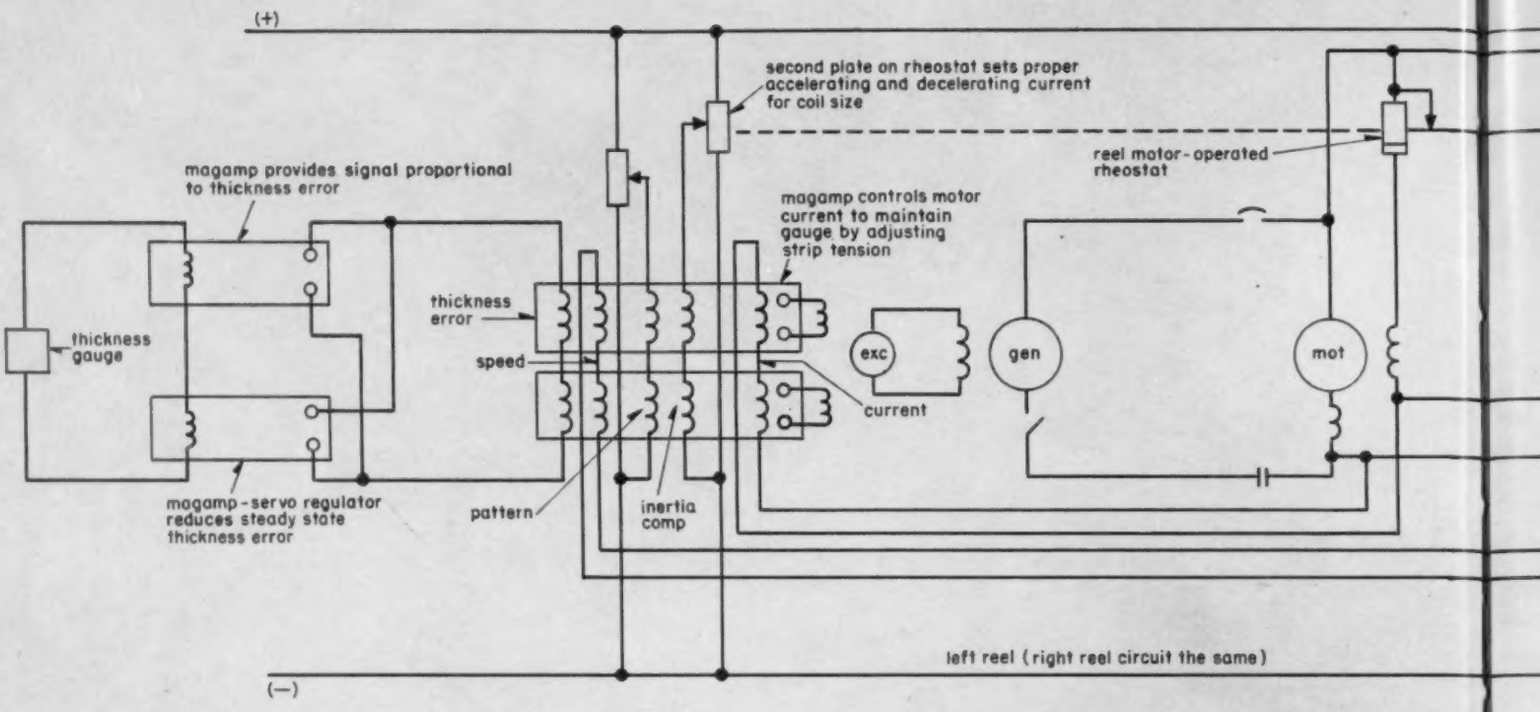
Today, developments in mill drives enable Westinghouse to help you gain closer tolerances with automatic control *this way* ▶

*Trademark

MP-3059

Operating control is centrally located on this console.

YOU CAN BE SURE...IF IT'S Westinghouse



Increase strip accuracy to ±.0001″

. . . with Westinghouse automatic gauge control

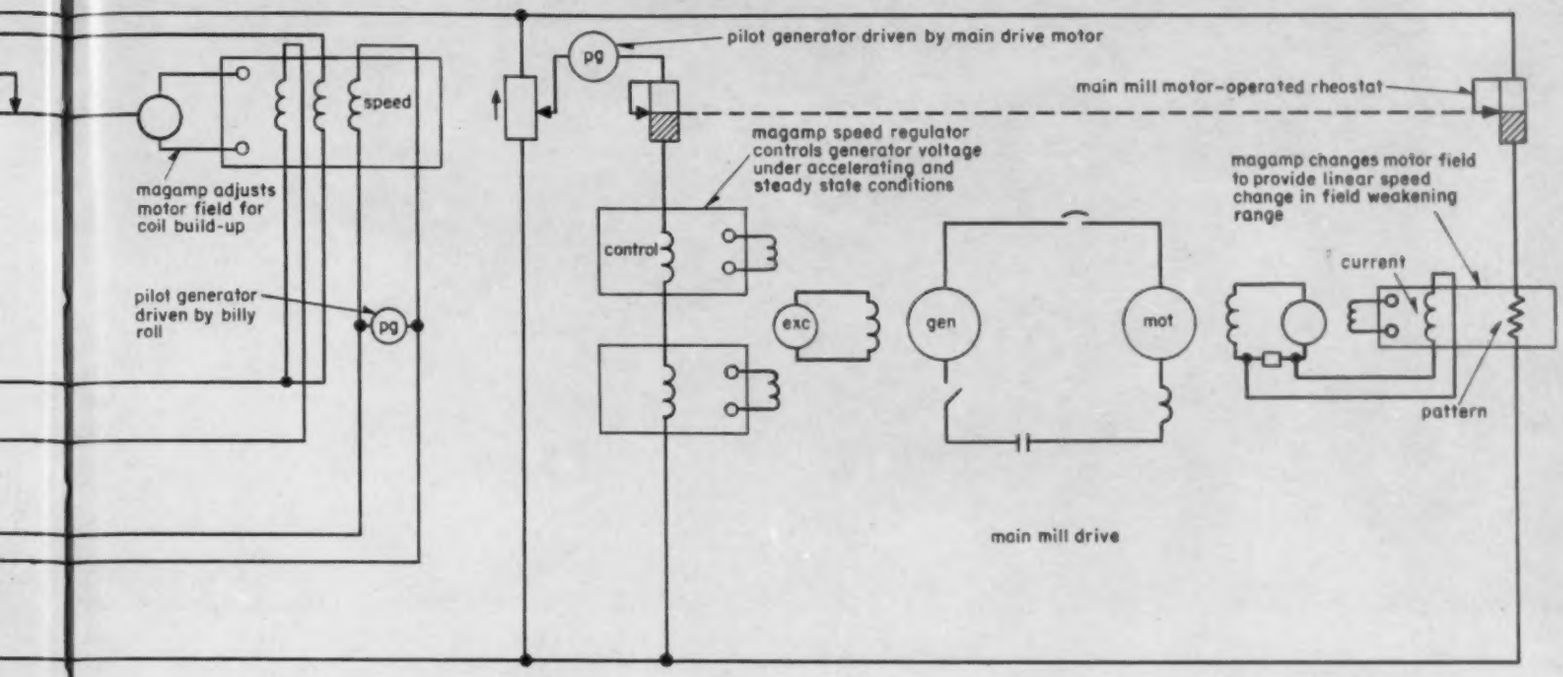
Increased accuracy and flexibility are engineered into Westinghouse drive systems for any single-stand, cold-reversing mill . . . such as shown above. Developments in automatic gauge control and Magamp regulator systems make it possible for you to maintain extremely close tolerance of ±.0001″. And, at the same time, you have ease of adjustment for quick change from one product to another. Here's how Westinghouse control and main drive equipment give consistant, high quality results:

Automatic gauge control circuit varies the strip tension to maintain uniform thickness of finished strip as measured by thickness gauge.

For mills equipped with regulating tensiometers, the signal from the tensiometer maintains constant tension by regulating the reel motor current. A tension rheostat furnishes the pattern field adjustment.

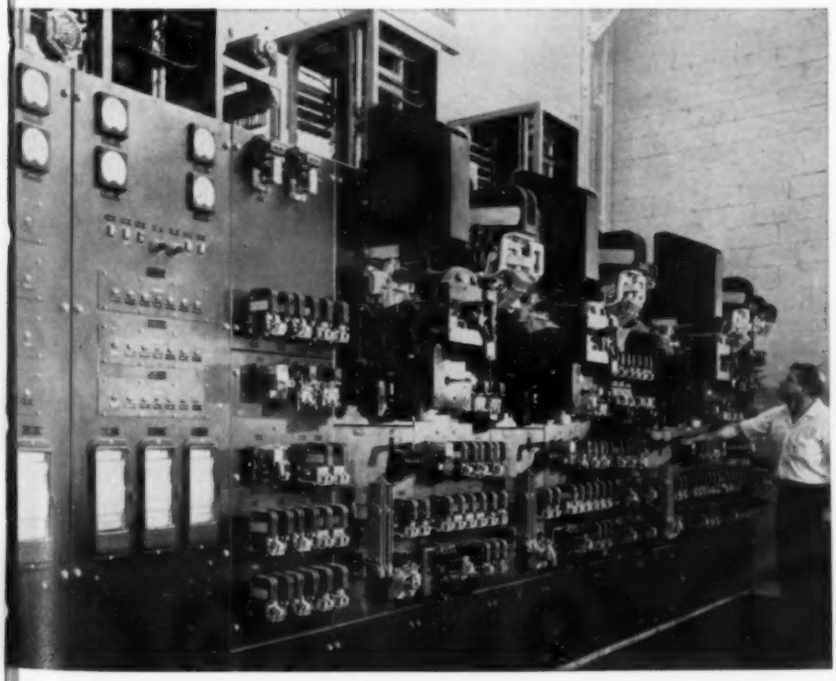
Magamp regulator system compensates for coil build-up by automatically regulating the speed of reel motors. Magamp's high amplification and extremely short response time assure accurate generator voltage control for optimum overall performance.

YOU CAN BE SURE...IF IT'S Westinghouse

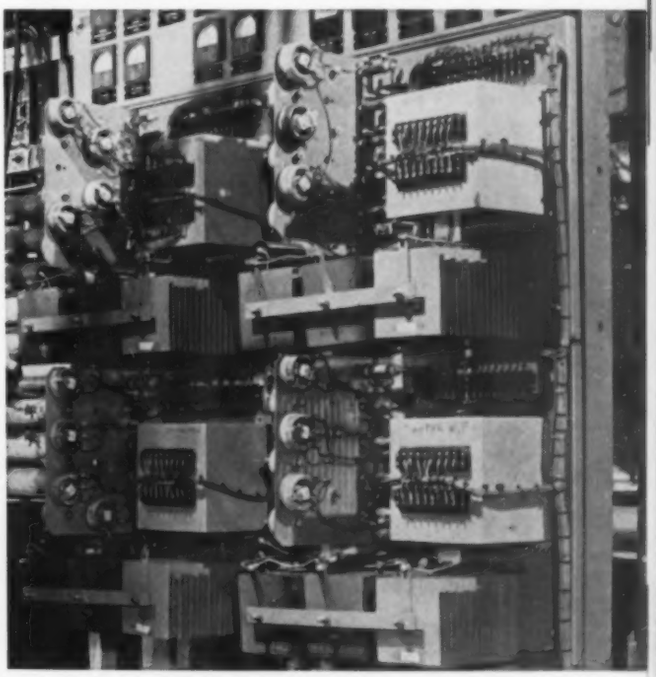

pilot generator driven by main drive motor
main mill motor-operated rheostat
speed
magamp adjusts motor field for coil build-up
pilot generator driven by billy roll
pg
magamp speed regulator controls generator voltage under accelerating and steady state conditions
magamp changes motor field to provide linear speed change in field weakening range
control
exc
gen
mot
current
pattern
main mill drive

Cold reversing mill system-diagram shows control that can be realized with Westinghouse motors and control components.

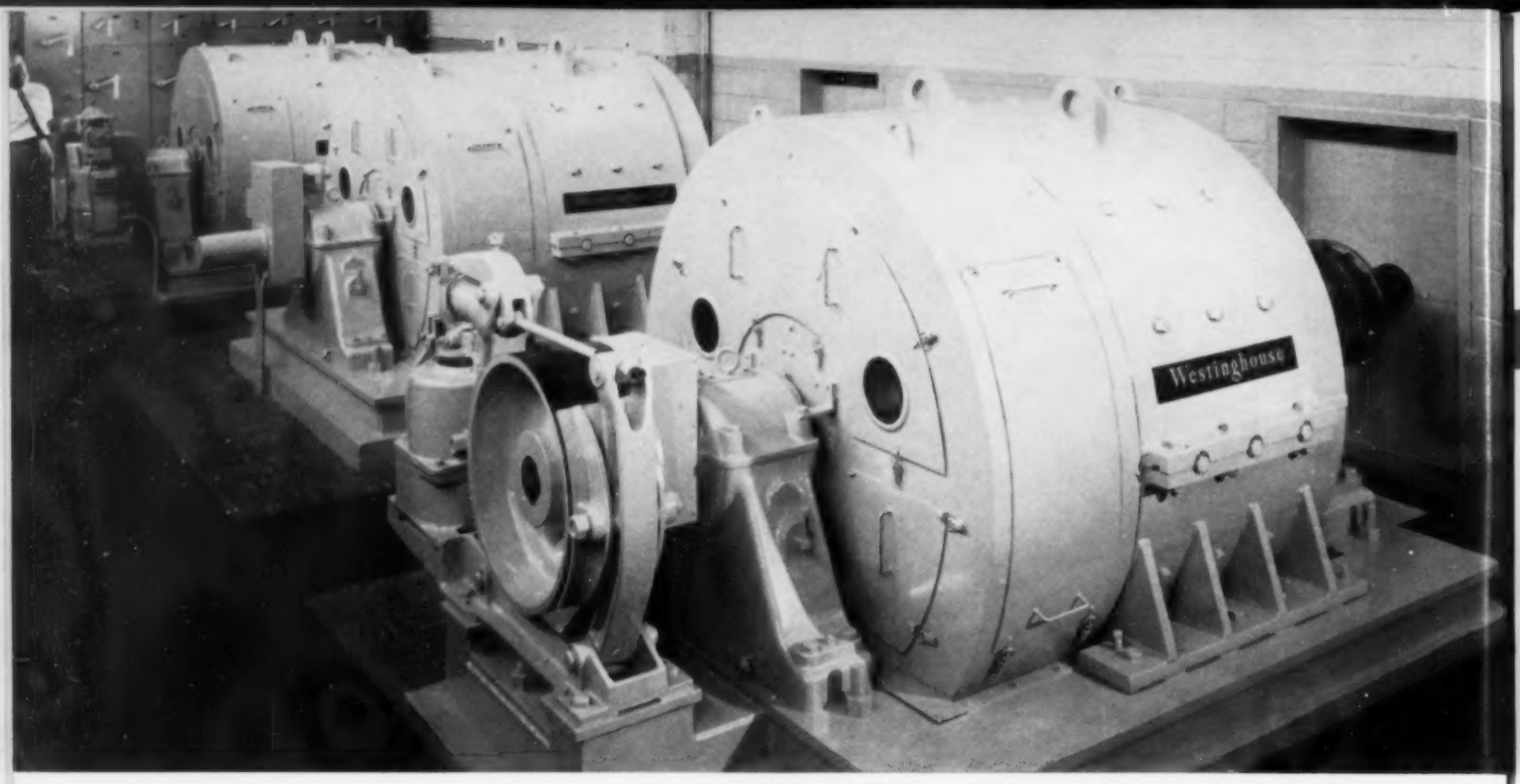
Main drive control panels with main circuit breakers (top) and memory-type fault finder on left. System faults are indicated instantly and recorded to make trouble shooting easy.



Magamp regulators are mounted in the rear of the main drive.

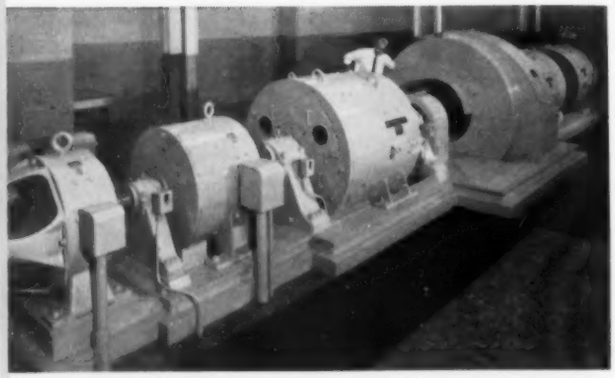


for dependable drive power . . .



Three 1250-hp 200/600-rpm motors are interchangeable for main drive and reels on typical Sendzimir mill. Oversize bearings insure longer bearing life and minimum maintenance.

Westinghouse drives are tailor-made to meet your specifications



Power for main drive motors of Sendzimir mill is supplied by three 125-kw M-G sets with three 1000-kw main drive generators and 3000-hp synchronous driving motor.

Life-Line® "H" motors with silicone insulation achieve up to 55% reduction in armature inertia by decreasing armature size. With commutating ability increased 35%, the Life-Line "H" assures faster reversing performance.

Westinghouse main drive equipment supplies the power needed for heavy reduction on Sendzimir and other cold rolling mills. Armature coils on all large rotating equipment are protected with Thermalastic® Insulation for three times greater dielectric strength under varying temperature conditions.

Rubber-mounted sight-glass windows on generators and motors provide for easy inspection of commutation under operating conditions. Commutator covers are easily opened for routine maintenance. Full-length commutating poles provide improved commutation under varying load conditions.

Westinghouse steel mill experience in all types of drive and control problems can help in your next planning or design session. A Westinghouse team will accept unit responsibility and work with your engineering staff. Contact your Westinghouse sales office or write: Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Penna.

YOU CAN BE SURE...IF IT'S

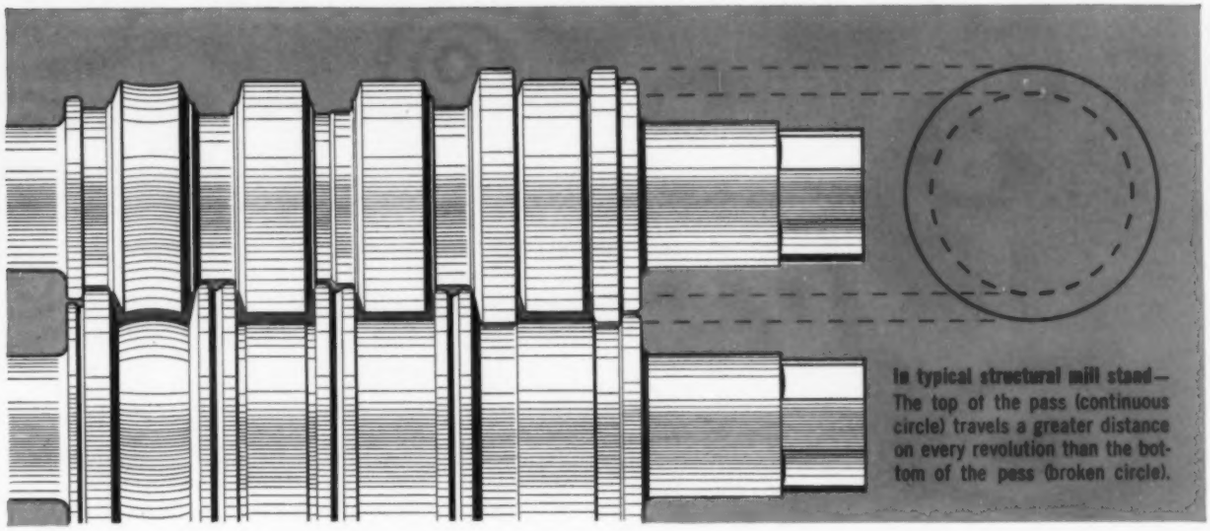
Westinghouse

TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

You get your nickel's worth in structural rolls



In typical structural mill stand— The top of the pass (continuous circle) travels a greater distance on every revolution than the bottom of the pass (broken circle).

With the large rolls used in beam, channel and other structural mills, excessive side wear in the passes is probably the most common cause of short runs between redressings. The reason, naturally, is the variation in peripheral speed at various pass depths. For example, the top of a typical pass on a 26" diameter roll may travel as much as a foot more on each revolution than the bottom of the pass. The slippage that has to occur aggravates this side wear in the passes.

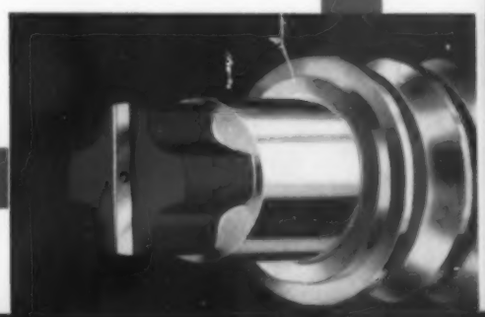
Thus, structural finishing rolls should be as hard as practical, with the hardness uniform from the surface in. While Mack-Hemp produces several types of rolls widely used in structural mills, the one which offers the best wearing properties—and the one we recommend for all large mills where wear is severe—is the nickel-alloy steel "M-H Midland Supermetal" roll.

The three virtues of nickel—The more carbon in steel, the higher its hardness can be raised by heat treatment. But, carbon also raises brittleness. Strength and resistance to shock and impact suffer.

However, as nickel is added, the strength of the steel increases. Thus, the introduction of nickel raises the permissable level of carbon, since the nickel counterbalances the embrittling effect of the carbon.

Because of its graphitizing property, nickel contributes two other virtues to the "Supermetal" roll. The graphite acts as a lubricant, reducing the rate of wear caused by the slippage in the pass. Secondly, the graphite formed due to the presence of nickel is very fine and well-dispersed, producing a structure that provides a smooth working surface.

The greatest wear resistance—Because of these properties conferred by nickel, Mack-Hemp "Supermetal" represents the best solution yet found to the wear problem created by severe operating conditions in structural mills. However, several other Mack-Hemp roll compositions give excellent results where conditions are less severe. For more detailed information on this—or any other—problem of roll selection, telephone or write us today. There's no obligation.



MACKINTOSH-HEMPHILL

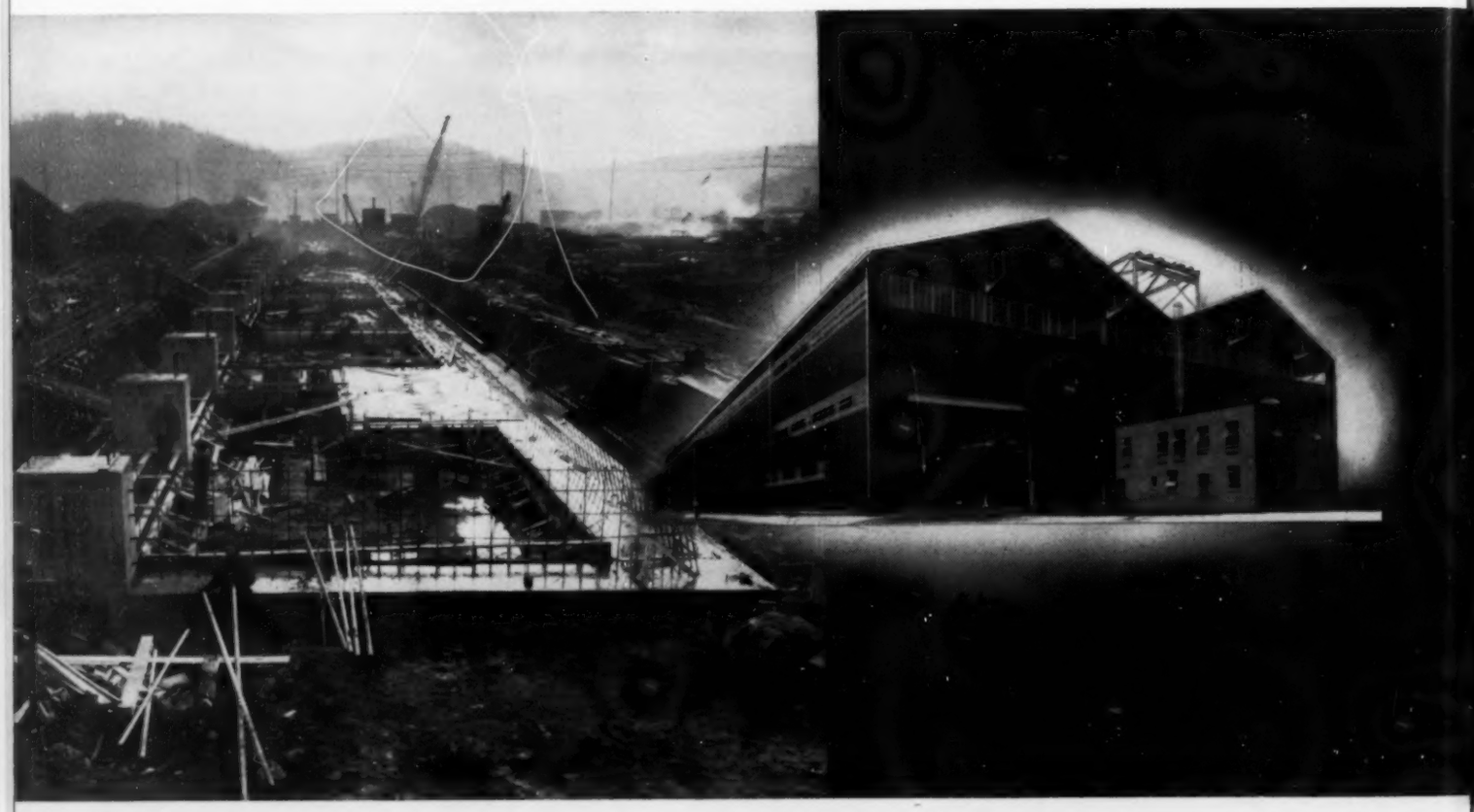
You get more tonnage from the rolls with the Striped Red Wabblers

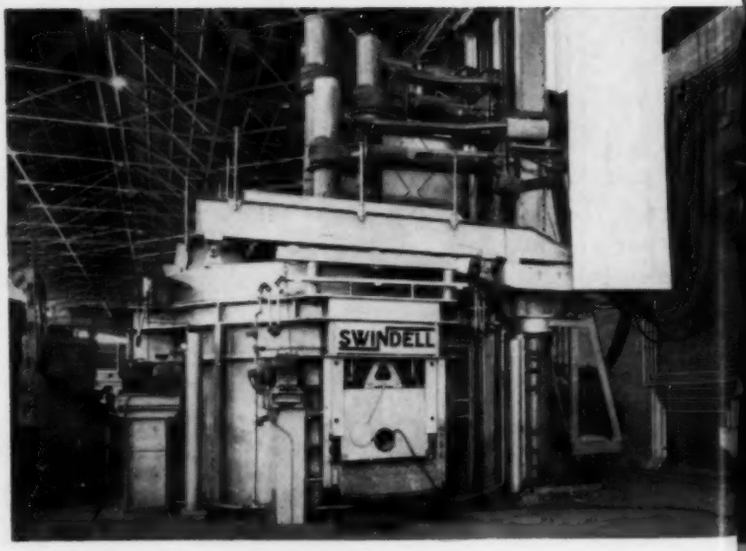
Division of E. W. BLISS COMPANY

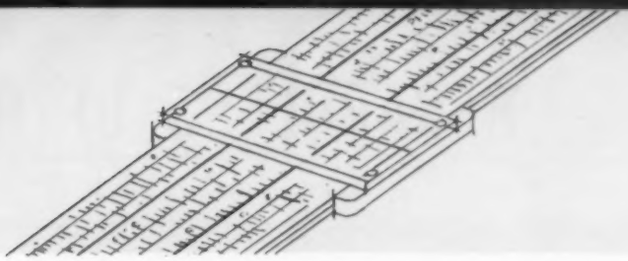
Presses, Rolling Mills, Special Machinery

SWINDELL-DRESSLER CORPORATION

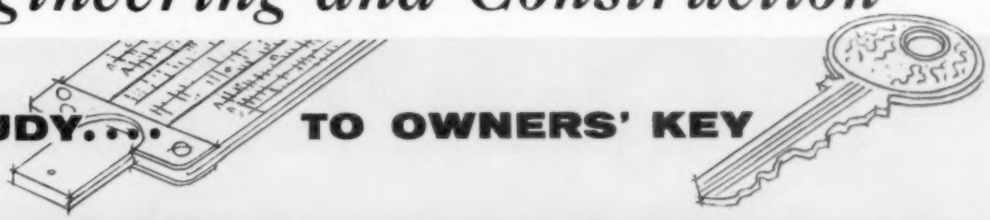
ELECTRIC MELTING DEPARTMENT







Design, Engineering and Construction



FROM STUDY.... TO OWNERS' KEY

SWINDELL-DRESSLER CORPORATION

ENGINEERS
CONSTRUCTORS
MANUFACTURERS

P. O. BOX 1888,
PITTSBURGH 30, PA.

The Melting Shop from the ground up, equipped and ready for the first heat of steel . . . a complete service rendered by Swindell-Dressler Corporation, engineers and constructors to the steel industry for over a hundred years.

Your inquiries are invited on complete Melting Department design and construction, modernization or re-equipment by this experienced organization. We will be glad to consult with you on providing cost studies, design engineering, construction management, equipment manufacture and procurement—any or all phases of your contemplated project. Write us in confidence for preliminary discussions.

REGARDLESS OF QUANTITY USED

RECARB-X®

does not increase sulphur content!

It is often desirable to charge an open hearth furnace with less pig iron and more scrap. When this is done, it is necessary to replace the graphitic carbon normally supplied by the pig with an outside carbon source. The one best carbon source is RECARB-X, for, when it is used, the *phosphorus and sulphur content of the charge are not increased.*

Because of its ease of solution in molten steel . . .its chemical inertness and its high resistance to oxidation, RECARB-X is an excellent material for ladle recarburizing of steel. It is non-toxic, in no way harmful to handle . . . and is extremely low in volatility, moisture and tramp elements. It can be employed to recarburize at all carbon levels, and carbon raises can be made over great ranges. Whether it be 2 or 20 points, results are always uniform and consistent. RECARB-X is a natural carbon source . . . a closely controlled product of natural GRAPHITE.

Engineering Bulletin No. 11 has been carefully prepared to give you complete information on the use of RECARB-X in basic open hearth practices, acid open hearth practice and electric furnace operations. Write for Bulletin No. 11.

GS-251-1

THE UNITED STATES GRAPHITE COMPANY

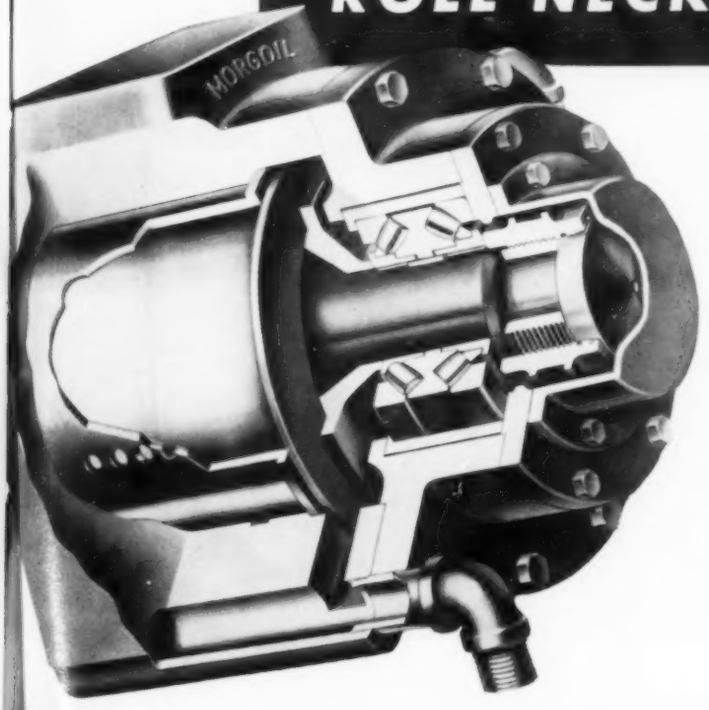
DIVISION OF THE WICKES CORPORATION, SAGINAW 9, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

For HIGH CAPACITY at ANY ~~SPEED~~

44"—90 MORGOILS—In action at speeds up to 7,000 feet per minute on 23" and 56" x 52" Five Stand Tandem Cold Mill. Weirton Steel Company, Division of National Steel Corporation.

MORGOIL
ROLL NECK BEARINGS



MORGOIL—the bearing that gives the greatest capacity and the longest life regardless of speed—gives modern high speed rolling mills top quality production with minimum down time due to bearing or roll neck failure.

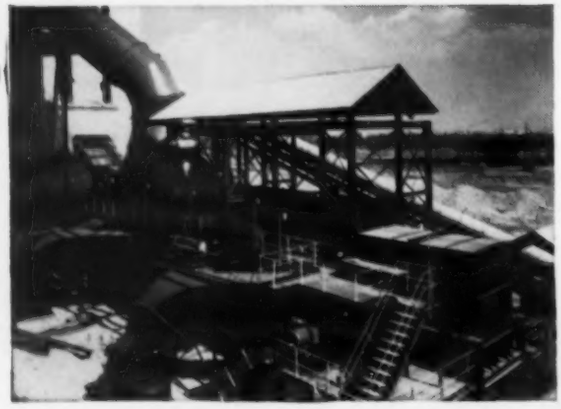
MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

ROLLING MILLS MORGOIL BEARINGS GAS PRODUCERS
WIRE MILLS EJECTORS REGENERATIVE FURNACE CONTROL

MB-32

A promise kept — Iron production records

Koppers Sintering Plant



STRAIGHT-LINE SINTER COOLER, at Sheffield, is 6' x 70' . . . air-cools sinter for safe handling by conveyor belts, and results in a superior product for the furnace charge.

set at Sheffield with

and Ore Bedding System

SINTERING PLANT was designed by the Freyn Department of Koppers for sintering fine ore, flue dust, filter cake, and limestone. The American Ore Reclamation sintering machine is 6′ x 89′ 3″. In initial operation, it is producing more than 2,000 net tons of sinter per day.

ORE BEDDING SYSTEM blends raw Mexican and local Texas ores. Built by Koppers Freyn Department, this installation can handle 500 tons of ore per hour.

This is a story of sound engineering on a truly complete "turnkey" basis. It is the story of the new sintering plant and ore bedding system recently placed in operation at the Houston Plant of the Sheffield Division, Armco Steel Corporation.

The installation was engineered and built by the Freyn Department of Koppers and typifies the service and results offered by Koppers to the steel industry. Briefly, the story at Sheffield is this:

A PROMISE—After a complete engineering investigation, Koppers recommended equipment and predicted the increase in blast furnace production that could be expected from the installation of a new sintering plant and ore bedding system.

FULFILLMENT—A contract was awarded and Koppers handled design, engineering, procurement, and construction . . . assisted Sheffield in starting up the plant and in instructing crews. Today, the Koppers sintering plant is exceeding all expectations and producing in excess of 2,000 net tons per day, much more than rated capacity. And the use of sinter and blended ore in the blast furnace—coupled with proficient operating practices employed by the Sheffield organization—has increased iron production to a record level, above the performance figure promised by Koppers.

Koppers experience and knowledge of the steel business can pay off for *you*—on any job from ore handling to the installation of a complete steel plant. Let the Engineering and Construction Division build your next job. Koppers Company, Inc., Freyn Dept., Pittsburgh 19, Pennsylvania.

SCREENING STATION separates blended ore into coarse, medium, and fines. The coarse and medium ores are delivered to the blast furnace bins; fines are conveyed to the sinter plant.

KOPPERS

KOPPERS

ENGINEERING AND CONSTRUCTION

Hydraulic Controls

by NORTH AMERICAN mfg. co.

Cleveland 5, Ohio

for PRESSURE, FLOW, and RATIO control... EDGE-GUIDE control... and AUTOMATION

For quick, reliable response to any demand, use a North American high-gain hydraulic amplifying relay. Its simplicity of operation as well as its rugged, compact construction provides a versatile component for the designer of control systems.

The relay is small enough to be mounted close to the process and its pressurized return permits installation above or below the reservoir and in any convenient position—on its side, upside-down, or at an angle.

Complete assemblies of relays, signal systems, pump units, and cylinders or individual components are now available to both users and original equipment manufacturers. North American engineers will be glad to discuss your application with you.
Write now for Bulletin 1-001.

4 Outstanding features in this Mead-Morrison Coal-Unloading Tower at "Con Edison"

This Mead-Morrison Coal Unloading Tower has been installed at the Astoria Power-Generating Station of New York City's Consolidated Edison Company.

●

Write for complete information on the many distinct advantages of Mead-Morrison Coal Towers and Bridges.

1

FAST UNLOADING—handles 850 tons of coal per hour with a 10-ton light-weight grab operating on a 43-second cycle.

2

DUST CONTROL—space above the 150-ton receiving hopper is enclosed on top, sides and rear to contain the dust, and a liquid spray system is provided to suppress it.

3

VARIABLE VOLTAGE CONTROL—pioneered by Mead-Morrison over 30 years ago for precise, flexible electrical regulation and economy.

4

ELEVATOR-EQUIPPED—the only travelling unloading coal tower with an elevator for operating and maintenance personnel and tools.

Additional features of this Mead-Morrison installation include a rigid hinged boom which can be raised to clear the dock line, braced frame riveted construction, and two-lever "dead-man" operator's control.

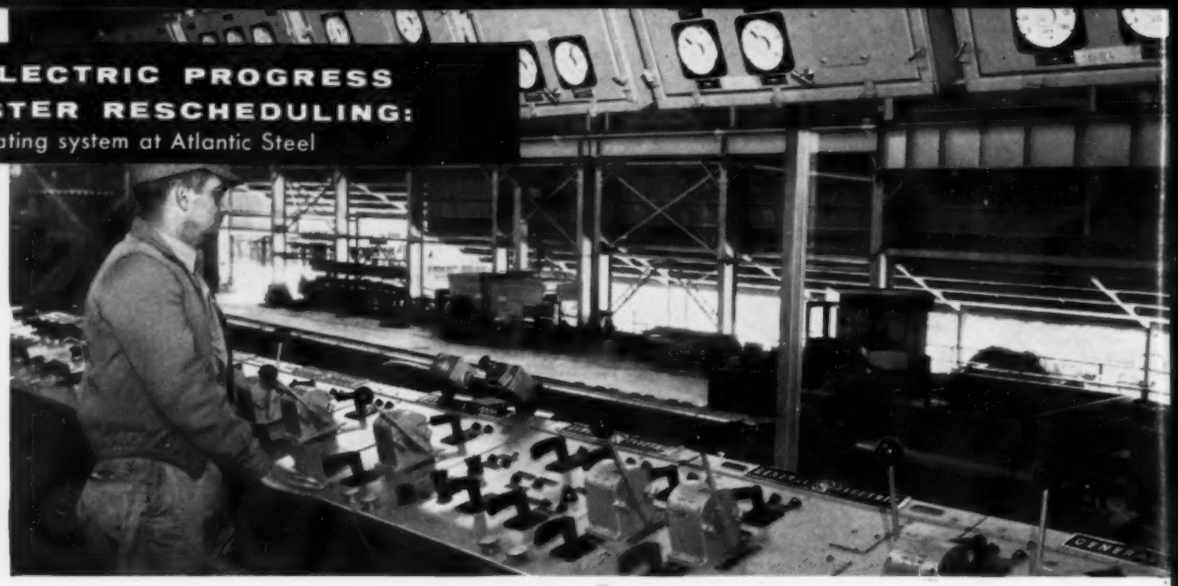
Mead-Morrison

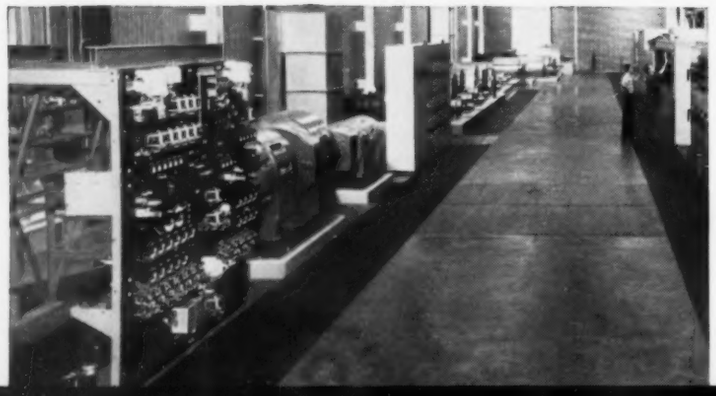
Division
McKIERNAN-TERRY CORPORATION
Harrison, New Jersey

MEB20

GENERAL ELECTRIC PROGRESS TOWARD FASTER RESCHEDULING:

Speed-regulating system at Atlantic Steel



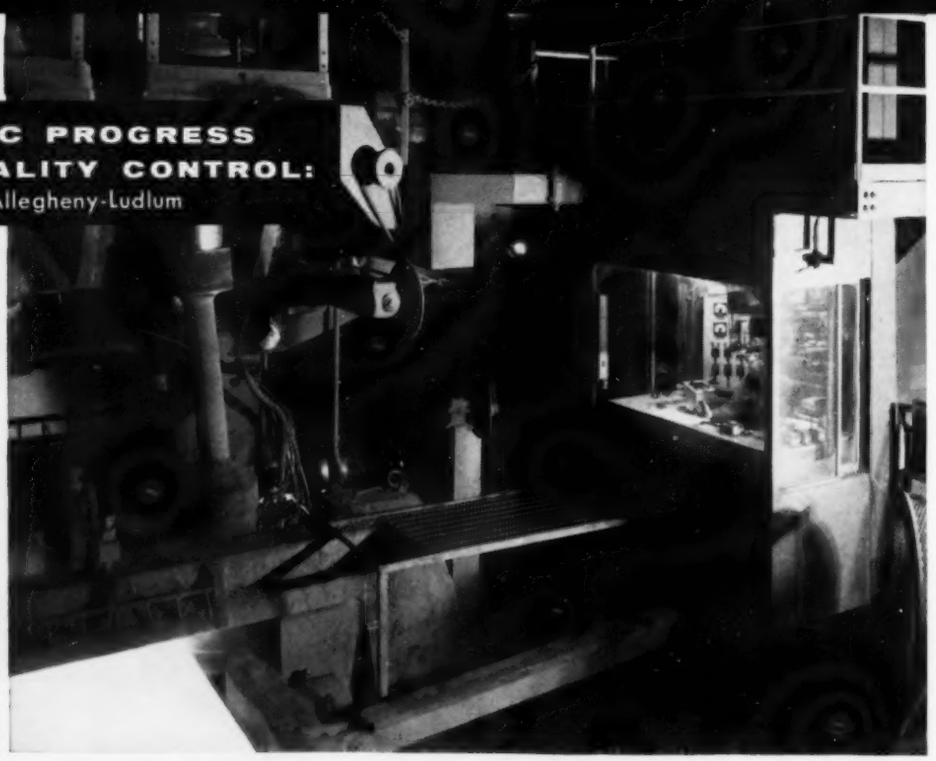


COMBINATION MERCHANT BAR AND ROD MILL at Atlantic Steel is one of world's fastest. Powered by a G-E co-ordinated drive system, it has a top speed of 5000 fpm for rods, 2000 fpm for merchant products. Pumpless ignitron rectifiers supply d-c power to main drive motors totalling 8450 hp. Centralized operator's control shown co-ordinates mill operations, permits using trained manpower most efficiently.

NEW AMPLISTAT-AMPLIDYNE SPEED REGULATING SYSTEM for mill motors holds 0.25% steady-state speed error from no-load to full-load, permits setting no-load speed essentially equal to rolling speed. This provides faster setting up and rescheduling. Faster response is also obtained to reduce over- and under-feed caused by impact speed drop, thereby minimizing buckling and pulling in the rod or bar.

GENERAL ELECTRIC PROGRESS TOWARD CLOSER QUALITY CONTROL:

Card program system at Allegheny-Ludlum

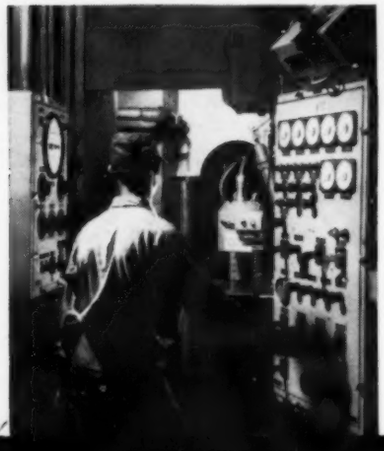


FOR FIRST TIME in the steel industry, a G.E.-developed punched-card system automatically programs and controls roll openings and mill speed on Allegheny-Ludlums Brackenridge reversing rougher, permitting closer tolerances, closer quality control.

GREATER PROCESS FLEXIBILITY is provided by G-E card program control. Using standard punched card compatible with accounting, data logging, and processing systems, operator can maintain large number of optimum schedules, for wide variety of products. A 15-pass schedule and product data is programmed on one card. Operator selects desired card, inserts it in "card reader" (see photo), and pushes "next pass" button to start each pass. Card control system automatically sets the screw position and mill speed for the pass. Accuracy of the system is 0.010 inches with a maximum roll opening of 9.99 inches. Settings are provided every 0.01 inches.

GENERAL ELECTRIC PROGRESS TOWARD GREATER PRODUCTION:
Higher speed with automatic gage control at Weirton Steel Division, National Steel Corp.

MORE AUTOMATIC OPERATION at Weirton Steel's new 5-stand tandem cold mill is provided by G-E automatic gage control. Shown below are X-ray indicator for Stand 1, X-ray gage, and operator's main control panel.



WORLD'S MOST POWERFUL, Weirton's new cold strip mill contains G-E drives totalling 28,000 hp. Specially designed to fit mill's rigid space needs, G-E low-inertia d-c drive motors (above) provide fast acceleration and balanced speed regulation. Automatic gage control, developed by G.E. for the steel industry, helps this mill produce higher quality steel, with closer tolerances, at higher rolling speeds. System utilizes X-ray gages at Stands 1 and 5 controlling thickness through screwdown position at Stand 1 and main drive motor speed at Stand 5.

THESE EXAMPLES OF DRIVE-ENGINEERING PROGRESS SHOW . . .

General Electric systems contribute to steel industry's increase in productivity

As the steel industry accelerates its evolution from mechanization to automation, there is an increasing trend to larger machinery, higher processing speeds, and greater production capabilities. Keeping pace with this trend, General Electric is constantly developing the new and improved electrical techniques, systems and equipment required.

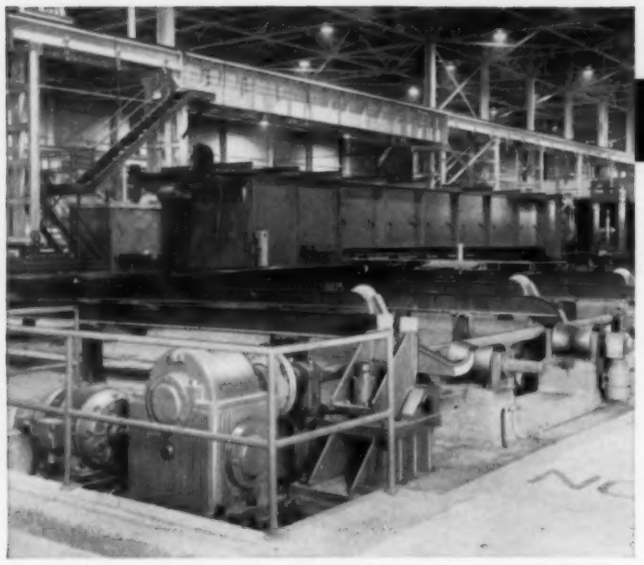
For example, horsepower levels on main and auxiliary drives are being raised, greater precision in automatic control is being achieved, and new methods of electrically regulating and programming work in progress are being used. New steel-mill drive systems are being designed—in close co-operation with steel industry engineers and machinery builders—to fit the still newer developments anticipated tomorrow. And system equipment continues to stress dependability and minimum maintenance to keep steel mill productivity high.

A few examples of General Electric developments along these lines are shown here. To serve *your* needs for automating electrically, profit from G.E.'s complete engineering services and system-engineered electric equipment. Contact your nearest General Electric Apparatus Sales Office. General Electric Co., Schenectady 5, N. Y.

659-118

Engineered Electrical Systems for the Steel Industry

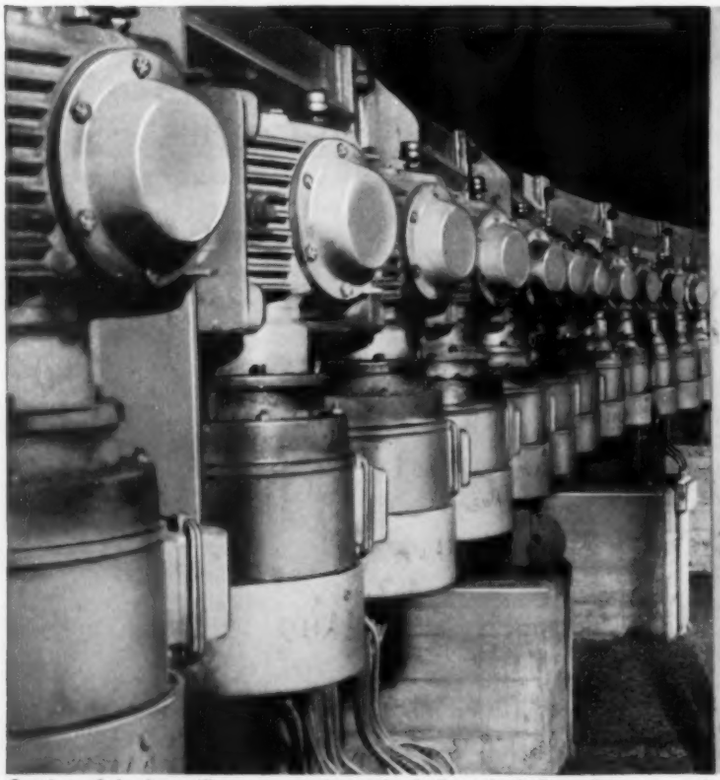
GENERAL ELECTRIC



Over 70 Star Wheel transfer drives are the roughest applications in the Mannesmann Tube mill. The Star Wheel shown picks up the heavy tube and transfers it to the transfer skids in one second's time with ⅓ of a revolution of the gearshaft of the Cone-Drive 12-inch center distance worm-under speed reducer. Reducer is driven by a 25-hp high-torque motor.

Plug mill is adjustable to handle diameters from 4½ to 10¾ inch finished OD. Adjustment is made by moving wedges coupled to an Acme threaded shaft driven by a hollow shaft 7-inch center distance Cone-Drive reducer. Power is supplied by 15-hp, 900 rpm high-torque reversing electric motor. Reduction is 40:1. Housing is only one in mill not made of ductile iron.

New MANNESMANN TUBE MILL makes extensive use of double-



Section of the hot mill conveyor, driven by hollow shaft Cone-Drive reducers, that takes bars from furnace to first piercing mill. Conveyor knocks scale from bars while turning corner and raising bars several feet. Hot 3,000 lb. bars travel at a fast rate and service is severe. Motorized reducers have 5:1 reduction. Motor base loosely coupled to stand acts as torque arm.

A 6-inch tube is shown here on a transfer skid between the cut-off machine and the longest conveyor in the Mannesmann mill—the main cold mill conveyor. Each roll on the conveyor, stretching as far as the eye can see, is driven with a motorized hollow shaft Cone-Drive double-enveloping worm gear reducer.

Almost 500 of these standardized individually motorized conveyor units are in use in the Mannesmann mill. Basic components are standard 3-inch center distance Cone-Drive hollow shaft speed reducer and 1½ hp electric motor. This drive is on the conveyor that takes cold bars from the burning machines to the furnace.

e- enveloping worm gear reducers

Mannesmann's new 20-million-dollar tube mill at Sault Ste. Marie, Canada uses 600 standard Cone-Drive speed reducers in its drives

Reflecting the latest in design and equipment, the new Mannesmann Tube Company, Ltd. seamless steel tube mill at the Canadian Soo will produce almost a quarter-million tons of tubing annually. It is the most completely automated tube mill in existence today and can truly be called a "push-button" production plant. The quarter-mile long plant will require an operating force of 500 men, most of them engaged in maintenance activities.

To keep maintenance to a minimum, Mannesmann selected and designed the most rugged equipment possible. One outstanding example is found in their use of Cone-Drive double-enveloping worm gearing in their drive systems. Cone-Drive speed reducers were selected because of their high load-carrying capacity, maximum operating life and minimum service trouble. Experience since the opening of the mill has justified this decision with no operating trouble being reported on the reducers.

With the exception of one unit, all of the 600 Cone-Drive speed reducers used are standard models with ductile iron housings. Capacities range from one to 60 horsepower. Almost every reducer is operating under some form of severe shock loading and this was another important consideration in their selection by Mannesmann engineers.

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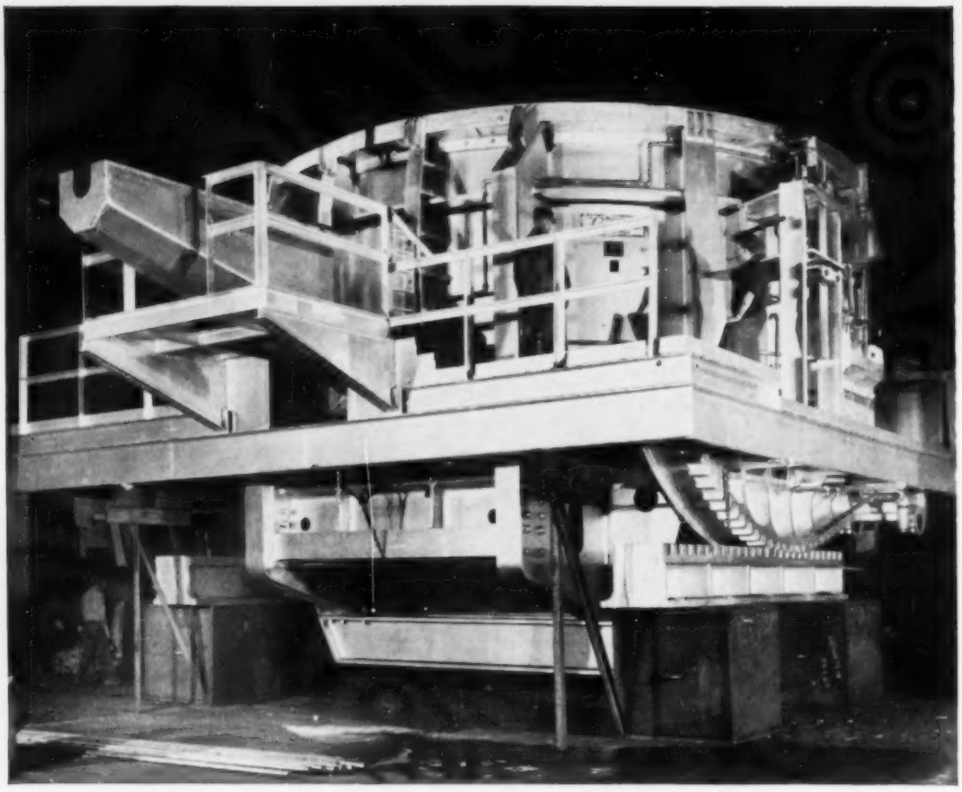

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Catalog 9-B describes Lectromelt Furnaces. For a copy, write Lectromelt Furnace Division, McGraw-Edison Company, 310 32nd Street, Pittsburgh 30, Pennsylvania.

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The Replacement of Steel Mill Plant and Equipment with Present Depreciation Reserves

. . . . the steel industry must replace its worn-out and obsolete equipment if productivity is to be maintained and increased . . . . present depreciation reserves are inadequate because of cost inflation, therefore tax laws must be changed to meet the problem . . . .

By WILLIAM T. HOGAN, S.J.
Professor of Economics and Director
Economics Program
Fordham University
New York, N. Y.

▲ THERE is a paradox in the steel industry today. Dollar profits have reached record heights, yet the industry is confronted with serious financial problems. In both 1955 and 1956 the industry earned about $1,100,000,000 after taxes, or better than $300,000,000 more than it did in 1950 when the previous all-time high of $766,000,000 was recorded. Yet, in spite of these record earnings, steel companies are pressed to find the funds needed for the replacement and modernization of their plant and equipment.

THE PROBLEM IN GENERAL

This paradoxical condition is the result of the sharp inflationary trend that has developed in our economy since World War II. It has brought with it increasing costs and declining purchasing power, as the dollar fell to one-half of its 1939 value. Measured in terms of the consumers' price index, the purchasing power of the dollar in 1956 was 49 per cent below 1939.

The index of construction costs, as published by the "Engineering News Record," indicates that the construction dollar has fallen to less than 40 per cent of its value 17 years ago. Thus, it takes two and one-half dollars today to build what one dollar would build in 1939 and 1940. This presents a serious problem in the replacement of worn-out facilities, for generally speaking, the equipment installed in 1939 at a cost of $1,000,000 could not be replaced today for less than $2,500,000, yet the depreciation funds set aside for this replacement amount only to the original cost, or $1,000,000. Thus an additional $1,500,000 is necessary if equipment is to be replaced and operations maintained.

This situation is applicable today to all industries that have long-lived equipment that is written off in a 20 to 30-year period. These investments made 20 years ago have felt the full impact of Post World War II inflation.

The critical nature of the equipment replacement problem was recognized by a few companies in the years immediately after the war, but many hoped that the inflation would come to an end quickly, as it did after World War I, and thus the difficulty would be resolved. The opposite has been the case. After World War I, the wholesale commodity price index rose from 131 in 1918 to 154 in 1920, and then broke sharply to 97 in 1921. By contrast the same index after World War II rose from 106 in 1945 to 190 in 1956. Thus inflation is here with a vengeance.

Up to date, no genuine solution has been offered, although the situation was somewhat alleviated by the limited application in the last few years of the Defense Production Act of 1940. The act allowed a 5-year write-off of war and defense plants so that the investment could be recouped in a short time, and thus prevent losses to companies installing plants exclusively for wartime use. The rapid amortization ended with World War II and was not restored until the Korean War broke out in 1950. Again it was applied only to those facilities deemed necessary for defense. Since 1956, however, very few certificates of necessity granting rapid write-offs have been issued.

The application of 5-year amortization is not a solution but a palliative, since, (1) it was applied only to those facilities deemed necessary for defense; (2)

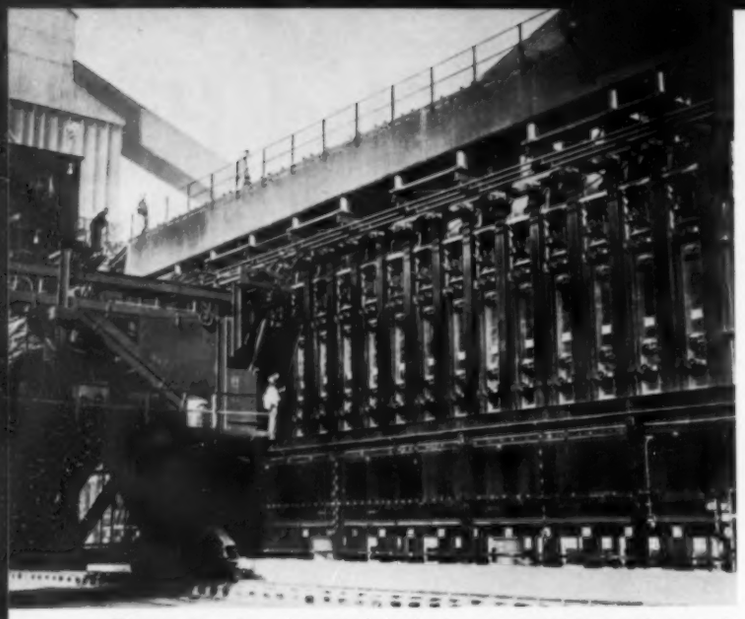


Figure 1 — In the steel industry a constant program is usually under way in which obsolete coke oven batteries are torn down and new units rebuilt. This 41-oven coke battery was put in operation in November, 1956.

it permitted the company involved to recover its original investment in five years and thus minimize the effect of inflation. However, it does not solve the problem of continued inflation, since the facilities written off in five years would be replaced, let us say, at the end of 20 years at a much higher figure than the original cost. This was the case with facilities installed during the war, their original cost was quickly recouped, but their replacement cost at present day prices is still much higher than the original figure.

THE PROBLEM IN THE STEEL INDUSTRY

Much of the equipment in the steel industry is large, expensive and long-lived; consequently, the industry has been particularly hard hit by the post war inflation and the lack of adequate depreciation funds for the replacement of plant. The average life of steel mill equipment is 20 to 25 years. Thus, at the present time, the industry finds it necessary to replace assets acquired in the middle and early 1930's. The original investment in this equipment, and consequently the depreciation accrual amounts to less than one-half their present replacement cost. The problem is further aggravated by the sheer size of investment required to produce iron and steel. At present the industry has $13,000,000,000 worth of fixed assets in operation, and a substantial portion of these must be replaced every year. At the relatively high rate of profit during 1955 and 1956; viz., $1,000,000,000, it would require 13 years to replace the industry's capital if every cent of profit were plowed back into the business.

One graphic illustration of the impact of inflation on steel mill investment can be had from the experience of a steel company between 1945 and 1948. A blast furnace was planned in 1945 with an appropriation of $8,000,000; by 1948, when the facility was finally completed, the total cost was $11,000,000, an overrun of some 40 per cent. Another company in order to replace its worn-out facility between 1946 and 1955 had to supplement each dollar invested from depreciation accrual with $1.30 taken from profits. Thus, $220,000,000 had to be taken out of profits to supplement $170,000,000 of depreciation allowances.

To solve its problem, the industry must raise substantial funds in addition to its depreciation accrual just to keep its present plant operating. In 1956, depreciation charges amounted to $743,000,000 which was between $300,000,000 and $400,000,000 less than was needed merely to replace worn out plant and equipment. This is a substantial figure, yet it has been estimated that it will increase during the next few years, and by 1960 will stand somewhere in the neighborhood of $600,000,000. The predicted increase of the deficit between depreciation accrual and actual replacement costs is based on several factors: (1) the hypothesis that inflation will continue; (2) the fact that the steel industry itself is growing and thus the amount of replacement will grow year by year; (3) the accruals from depreciation will remain almost constant during this period. This last factor bears some explanation for one would expect with a growing industry that the number of dollars of depreciation charged off each year would likewise grow. However, it should be noted that a large portion of the 1956 depreciation charges came from rapid amortization which accrued from a 5-year write-off of certain newly installed facilities. By 1960, these facilities will be almost completely written off, and the total amount accruing from this rapid amortization will diminish almost to the vanishing point. Thus the normal source of depreciation funds will increase, but this will be offset by the decline of rapid amortization funds.

Having established the need for the extra money to supply the deficit between the amount needed to replace facilities and depreciation accruals, the next question to be answered is where will it come from. Several expedients have been suggested, but none have solved the problem. The first suggestion was that the money might be borrowed. This could work for a year or two as an emergency measure. However, let us keep in mind that the problem is one that recurs annually. The money will be needed every year, and no one can go on borrowing large sums every year without facing bankruptcy, yet it should be mentioned that there is one set of circumstances under which continued borrowing could be permitted. It could be done if the return on the newly installed equipment were great enough to pay the interest on the debt and amortize the loan as well. This would mean a saving of 10 per cent about half of which could be used for interest payments and the other half for amortization. Very few facilities, however, have yielded a saving of this magnitude.

In connection with the matter of borrowing, some, words of clarification are in order. It is a fact that many companies actually do borrow money to replace their assets. This is particularly true of those companies who do not have a large uniform replacement program year by year. There may be a period of three or four years where no large outlays are made, and then suddenly they are confronted with sizable expenditures, perhaps a blast furnace, a battery of coke ovens, or a rolling mill must be replaced. The depreciation funds accrued over the years may have been used for working capital and are not now available, so a loan is negotiated to pay for part, or all of the replacement. It is clearly evident,

however, that this loan is not for the replacement of assets but a postponed operation which should have taken place to provide working capital during the preceding years.

The second expedient is the sale of stock. This would at first sight seem to have possibilities for it has been maintained that the book value of the company would be increased and the actual dollar investment of the original shareholders would be protected. For example, if a company was worth a million dollars and issued an additional million dollars in stock to new shareholders in order to obtain capital merely to replace its plant, many would maintain that the original stockholders still have a million dollars equity in a plant now worth two million. However, the original shareholders, who formerly owned the entire plant, now own only half of it. Further, since this is a replacement and not an expansion, we have no right to assume that any more goods will be produced and so earnings should remain relatively stable. This would mean that the dividends to the original stockholders would be cut in half since there are now twice as many stockholders to satisfy with the same income. Lastly, it seems doubtful that anyone would buy stock in a company that was not making enough to cover its costs of production, and the wear and tear on facilities is definitely a cost of production.

Thus we can reject these two expedients as solutions to the problem and consider the third; viz., the investment of retained earnings. This approach seems, under the present circumstances, to be the only sound one in spite of the fact that it has limitations and results in distortions that are not always fully recognized. It has been used by many companies to solve the urgent problem of supplementing depreciation reserves to replace worn-out obsolete plant and equipment.

The problem obviously had to be met for two reasons: First, the industry had to replace worn-out plant to stay in business. This is evident and needs no elaboration. Second, the industry had to replace economically obsolete plant, if productivity was to be maintained and increased. This second reason, though not quite as evident as the first, is of considerable significance since the maintenance of productivity is of prime importance to the steel industry and the economy in general.

There are several reasons why productivity must be maintained and increased:

1. It is the principal means at our disposal for increasing the nation's wealth. Productivity is a ratio between the input factors in production; namely, labor, raw materials and capital equipment, and the resultant output. Thus, if we get more product per man-hour, per unit of raw material and per machine, we are actually increasing our wealth.

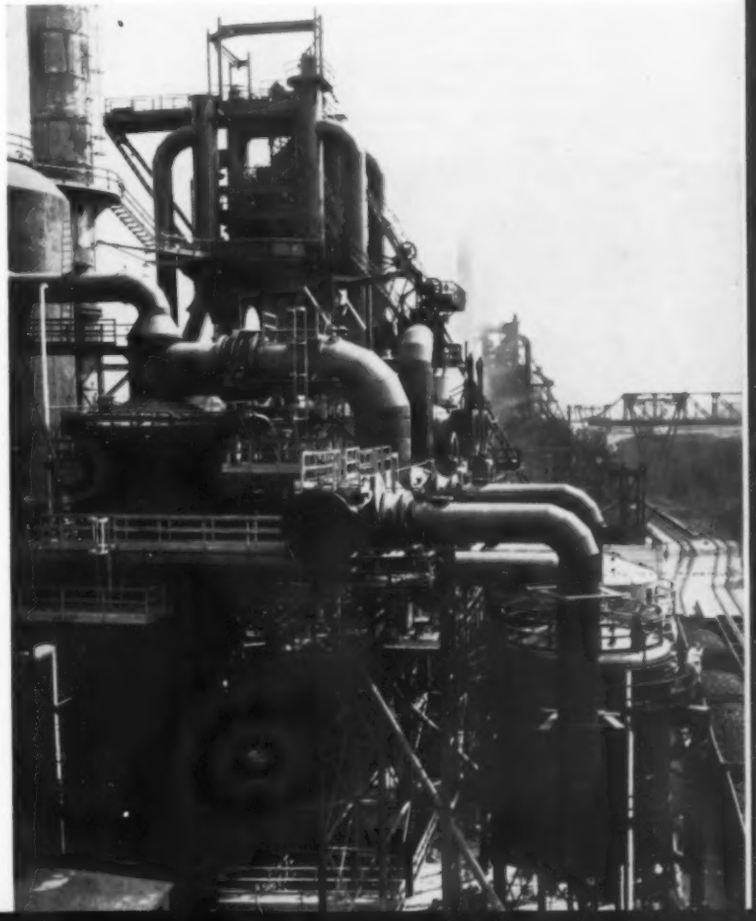
2. Productivity is a means of controlling inflation. If production yields are higher, it is possible within limits to increase wages and dividends without increasing prices.

3. Productivity presents a means to compete with foreign producers. Foreign competition is not yet a general problem in the steel industry, but has been felt in certain areas. It will probably increase in the future because many of the antiquated and obsolete steelmaking facilities in Europe and the Far East destroyed by the war were replaced by the latest in steel mill equipment which will operate at lower costs and give better quality. The difference in wage rates between the United States and the foreign competition is considerable, so that our only hope of meeting this competition in the future is through greater efficiency.

In almost every phase of the steel industry, improved plant and equipment is a requisite for greater productivity. Much can be done, it is true, by improved practices, incentive plans and beneficiated raw materials, but these approaches have their limitations. In fact, raw material beneficiation can only be accomplished in many cases by the installation of machinery such as taconite and coal washing plants. Therefore, if we are to obtain increased efficiency and productivity, not only physically worn out, but economically obsolete plant and equipment must be replaced. We must be in a position to make use of the advances in technology if we are to increase our output and operate more economically. If obsolescence replacement is not carried out because of inadequate depreciation funds, the steel industry will fall behind and our general economy will suffer.

The replacement of obsolete equipment can increase production as well as productivity. Let us take an example. A mill for rolling cold reduced sheets installed in the middle or late 1930's had a speed of 3000 to 4000 fpm; its counterpart today is rated at between 5000 and 6000 fpm. Thus, the replacement runs at a much higher rate than the old mill and provides an increase in cold reduction capacity. This should not surprise us but should rather be expected, for if it were

Figure 2 — The cost of new blast furnaces has risen to the point that many companies can neither obtain the capital nor justify new blast furnace plants. Additional pig iron is being obtained through improved operations, beneficiated ore, use of oxygen and so forth.



not so after twenty years of development, it would be a sad commentary on our technological progress. The increase in capacity is only potential, however, unless there is more steel available to put through the mill.

The example brings up a much debated point in this discussion of depreciation. One faction maintains that a new mill cannot be considered a replacement strictly speaking for it is also an expansion, and it is further argued that virtually no asset is replaced in kind, but always with a superior one. This is true, but the problem is not easily solved for it is often difficult to decide how much of the new equipment is replacement and how much is expansion. Expansion is only potential until it has been achieved across the board in every phase of the company's operations so that more steel is actually produced.

Another factor to be considered in the equation is the improvement in the product quality brought about by the new facility. Recently, one company replaced two mills with one modern mill. The modern mill cost considerably more than its two predecessors, but yielded a slightly higher output and a much better quality product.

The improved quality and increased quantity of steel resulting from the replacement of obsolete mills only point up the need for the installation of modern equipment whenever it is economically feasible.

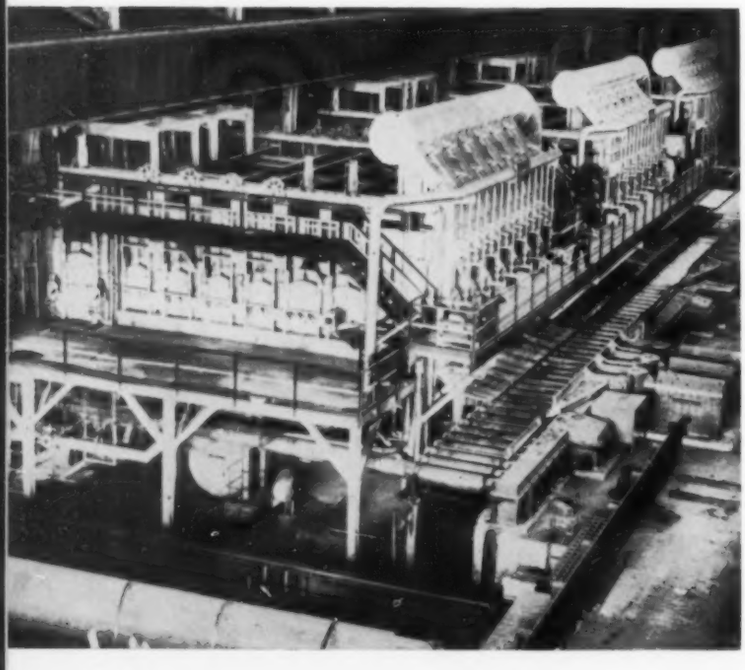
THE EFFECT OF INADEQUATE DEPRECIATION RESERVES ON PROFITS

The expedient of reinvesting earnings to compensate for inadequate depreciation reserves has distorted steel industry profits since the close of World War II. Profits, or rather taxable income, is determined by subtracting from gross income the full cost of doing business which cost includes charges for depreciation and amortization. However, the industry, because of tax laws, has not been able to charge off adequate depreciation on its facilities with the result that its profits are inflated by the difference between the actual charges and those that should have been made. Some $300,000,000 to $400,000,000 had to be reinvested out of earnings in 1956 for replacement of facilities. This amount should have been charged off before profits or taxable income was determined. Consequently, the $1,100,000,000 recorded for that year is seriously inflated. Taxable income before taxes should have been $300–400,000,000 less, and after the application of a 52 per cent income tax, the net profits would have been $150–200,000,000 less, or aproximately $900,000,000.

If adequate depreciation was taken in 1956, it would have still been the record year for dollar profits since the industry has never before approached $900,000,000. Its previous World War II records of $608,000,000 in 1916 and $454,000,000 in 1929 are far short of the 1956 figure. However, in terms of 1956 dollars, the 1916 profit should be adjusted to $1,500,000,000, and the 1929 figure to $750,000,000. Thus the record year by far was 1916. What is even more remarkable is that the 1916 figure was made on an ingot tonnage production of 47,000,000, and the 1929 figure on a production of 63,000,000 ingot tons, while the output in 1956 was 115,000,000 tons.

There should be no mystery about record dollar profits in 1956 when production was virtually doubled that of 1929.

Figure 3 — These three reheating furnaces were part of a renovation program which has increased production appreciably. Furnaces have a capacity of 200 tons per hr each.



THE EFFECT OF INADEQUATE DEPRECIATION RESERVES ON PRICES

Prices must provide enough income to a firm to cover its cost of production, or the firm will soon be insolvent. As previously stated, wear and tear on capital equipment is a cost of doing business, and unless it is fully provided for the business is in process of liquidation, and in effect, is subsidizing its customers.

In order to replace equipment the steel industry has had to have prices high enough to make profits that would help cover the cost of replacement, since according to the present tax laws it cannot charge off enough depreciation to cover this cost. Further, with a 52 per cent income tax rate, the industry must earn $2.00 before taxes for every dollar of profit it spends for replacement after taxes. Consequently, prices are higher than they would be if adequate charges for depreciation could have been taken before taxes. For example, the ABC Steel Co. must take $10,000,000 out of net profits to supplement its depreciation funds, it will have to earn over $20,000,000 before paying 52 per cent in taxes on its gross profits. The principal and often only means for the company to accomplish this is through the prices of its products.

In view of this situation, it is difficult, if not impossible, for an industry, which must have high revenue to offset inadequate depreciation, to absorb any substantial cost increment without increasing prices. The recent wage-price increase in the steel industry is a case in point. The wage increase, plus increases in the price of purchased goods and services will amount to hundreds of millions of dollars. To absorb such an increment in cost is manifestly impossible if the industry

is to maintain an active program of replacing its worn-out and obsolete plants with new, more productive equipment. To accomplish this, in 1956 the industry had to take $350,000,000 from its $1,100,000,000 in profits to supplement the $743,000,000 charged off for depreciation. It seems clear that it could not absorb several hundred million dollars more of cost and remain a good investment producing an adequate return on its capital. Prices, therefore, have to be set to take care of these needs, for if the cost of plant and equipment is not recouped by a company, it is paying dividends out of capital rather than earnings. Further, if the industry does not generate adequate funds for replacement, one wonders where the funds for needed expansion will be found.

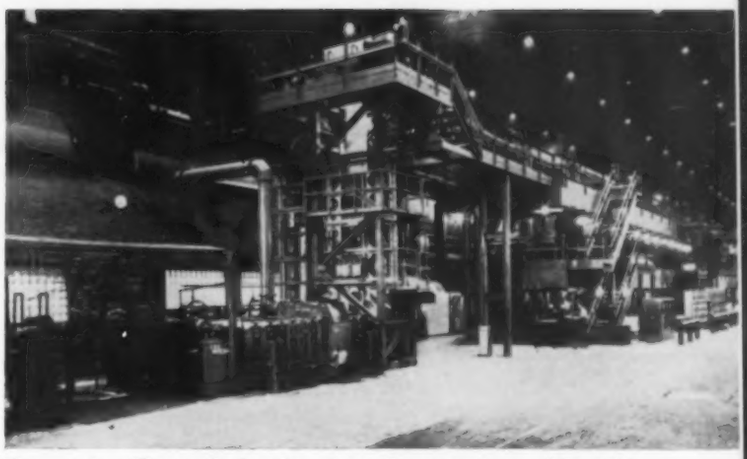


Figure 4 — Electrolytic tin plate lines such as this unit help elevate the standard of living by producing economic tin plate.

SOLUTIONS TO THE PROBLEM

Thus far we have stated the problem of inadequate depreciation and its effect on productivity, prices and profits. It now remains to consider possible solutions.

The basis of any solution must lie in some type of tax reform. A means must be worked out by which enough depreciation can be charged off to provide a great part, if not all, of the cost of replacing plant and equipment. At the present time, it is only possible to reclaim the original investment cost. The details of the solution will be somewhat difficult to work out for they depend on just how much the tax laws will allow industry to write off and on what basis.

The problem was relatively simple when only the original costs were to be recovered. The life of an asset was determined and a percentage of the asset's value was written off each year until 100 per cent of the original cost was reclaimed at the end of its life. An alternative method was to group all the assets together and charge off a percentage of the total property account each year. In the steel industry the mechanics of the second method could be worked out in two ways: (1) A flat 4½ per cent could be charged off each year, or (2) depreciation could be taken as the basis of an activity rate with 5 per cent allowed for 100 per cent of operation, 4 per cent for 80 per cent of operation, 3 per cent for 60 per cent, etc.

When we talk of recovering more than the original cost of our investment, or more correctly, recovering the original cost of investment in terms of purchasing power, difficulties arise. How is this to be done? What would be the basis for revaluation? Fundamentally, the solution arrived at must flow from an analysis of the concept of depreciation which has evolved from the fact that capital wears out at a fraction of its value each year. Because of this basic premise, it is difficult to make accurate predictions on replacement needs for first, a forecast of the life of the facility involved is required. This is difficult since a piece of equipment may have a longer or shorter lifetime than predicted. Secondly, the valuation changes because of obsolescence and fluctuations in the price level. Therefore, the solution will have to be based on a flexible norm which can be adjusted to these conditions.

Several solutions for the problem are possible. All involve a revaluation of plant and equipment on an annual basis by means of a cost or price index. Since this is not a problem for the steel industry alone but a number of others as well, it may be necessary to construct several indices for different types of industries for it is conceivable that the index applied to the steel industry might have a different composition than that which would apply to the clothing industry. However, these are details that do not present insurmountable obstacles.

The first solution offered involves a procedure whereby the total plant of the company is revaluated each year and the percentage of depreciation charge remains constant. For example, if a company has depreciable property valued at $1,000,000 in 1957 on which it takes 5 per cent depreciation, and if the index shows an advance of 2 per cent in 1958, then on this basis the company's property is revalued at $1,020,000 which is likewise depreciated at 5 per cent. In the next year if the index increased another 2 per cent, the property value would increase to $1,040,400 on which 5 per cent of depreciation would be taken. In this way the total cost of the wear and tear on capital equipment would be recouped and a more realistic depreciation policy would be in operation.

A second solution is proposed which could be used by companies who charge depreciation on an individual asset basis rather than a composite of their entire property. It would require: (1) an index to revalue the assets each year; (2) the determination of the life span of each asset; (3) that the amount written off would be deducted from the original value and the resultant value spread over the remaining years of life. In this way the full replacement value could be recovered.

An example will illustrate the method. Let us assume that we have an asset valued at $100 with a 5-year life. Let us likewise assume an inflation of 10 per cent per year over the base year. Thus at the end of the first year, the asset is revalued at $110 of which 20 per cent or $22, is written off. The next year the asset would again be revalued at $120 because of inflation, but the $22 in depreciation taken the previous year would be deducted so the remaining value is now $98. The $98, however, is to be written off over the four remaining years, and so 25 per cent, or $24.50, will be charged against depreciation for the second year. This procedure is followed, as Table I indicates, until the fifth year when the full replacement cost will be reclaimed.

A third solution proposed would permit a company to

TABLE I

	Original cost adjusted for inflation	Previous depreciation allowance	Adjusted basis	Current depreciation charges
	$100	...	...	...
End of first year	110	...	$110.00	$ 22.00
End of second year	120	$ 22.00	98.00	24.50
End of third year	130	46.50	83.50	27.83
End of fourth year	140	74.33	65.67	32.84
End of fifth year	150	107.17	42.83	42.83
				$150.00

charge off in any given year the difference between the original cost of the asset which is replaced in that year and the actual replacement cost. This difference would again be established by an index. Here, however, it would not necessarily mean that the identical asset must be replaced, but the purchasing power of the dollars originally paid for the asset should be reclaimed and invested perhaps in other equipment. For example, a company might decide to shift its product mix by going out of the wire business and into the sheet business. Under these circumstances, the original purchasing power of its investment in wire facilities should be reclaimed and then applied against the purchase of sheet facilities. It should be noted that this deficiency is made up only when the property represented by the original investment is disposed of and the equivalent in current dollars is spent on other property. This system of writing off in one year the difference between original investment and the current purchasing power of the dollar represented by that investment is good, if the amount involved is relatively uniform year by year. However, if the reinvestment takes place in what is known as a "lumpy" fashion; i.e., a fairly large investment every three or four years and a relatively small investment in the intervening years, some accounting adjustment would have to be made so that the depreciation could be taken for tax purposes, and yet not influence the profit statement too severely.

These are solutions that have been proposed. There are advantages and disadvantages involved in all three. However, they represent a genuine attempt to alleviate a difficult situation. The problem is severe and cannot be ignored. It is not the industry's problem alone, it is the nation's problem. The steel industry must replace its worn-out and obsolete equipment if productivity is to be maintained. The steel industry must also expand through the addition of new capacity if the needs of our country's economy are to be met. But we cannot expand unless we first replace equipment that has worn out. Rapid tax write-offs and other accounting devices such as the sum of year's digits and the declining balance method have helped to a degree, but they have not solved the problem of inflation. This can be solved only by a basic change in the tax laws, and it is hoped that a realistic approach will be taken in the near future.

DISCUSSION

PRESENTED BY

HARVEY J. HAUGHTON, Vice President & Controller, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

WILLIAM T. HOGAN, S.J., Professor of Economics and Director, Economics Program, Fordham University, New York, N. Y.

ROBERT E. LAUTERBACH, Secretary, Pittsburgh Steel Co., Pittsburgh, Pa.

Harvey J. Haughton: As Father Hogan indicated, all three of these solutions have to be based on acceptance for tax purposes. The thing that bothers me is: How can we present this in such a way that the solutions are not tagged as some kind of a special subsidy or a special tax "gimmick?"

Obviously, the individual citizen has some problems for loss in value due to inflation, also, and these solutions you suggest will of course, relate strictly and solely to business, and in many cases the long-lived, expensive pieces of equipment are found in big business. How can we avoid the tag of subsidy?

William T. Hogan, S.J.: It has been said that the proposal constitutes a subsidy for the steel industry. The proposal would not be a subsidy, but would rather solve a difficulty that exists, not only in the steel industry, but in every other industry that has long-lived equipment. This point should be stressed vigorously. Every industry with equipment that wears out over a period of from 15 to 30 years is faced with this problem.

The second part of the question refers to the plight of the investor, particularly, the bondholder. He has been a victim of inflation as his equity in terms of purchasing power declined during the past fifteen years. I appreciate the difficulty, but this paper covers a solution of a particular phase of the problem of inflation; viz., that involving industries with long-lived equipment. No attempt was made to offer a general solution for inflation, but there is no reason why one should not attempt to solve part of the problem even though he cannot solve it all.

Robert E. Lauterbach: With respect to your last point, you stated that the tax laws would have to be amended for any of these solutions to be made effective. Would you care to comment further on the position of the Federal Government in support of any legislation that would produce these additional depreciation allowances and result in considerable losses in tax revenue to the country?

William T. Hogan, S.J.: The solution I have proposed today would result in a temporary loss of tax revenue to the Federal Government. However, if, as I have pointed out, industry has adequate depreciation charges and can replace obsolete, as well as worn-out equipment, it will increase its efficiency and productivity and thus provide a broader base of profits from which the government can draw tax revenue.

If a solution is not worked out in terms of granting adequate depreciation, it will be necessary for industry to obtain the revenue through prices which must also cover tax costs. Further, if the steel industry does not replace its obsolete equipment as rapidly as it should, one wonders where it will get the money to expand, and if it does not expand, we will have a tight situation on steel supply such as we had in 1948 and 1955, and the economy will be hampered.

Roll Pass Design for Combination Structural and Wide Flange Beam Mill

By HERMAN E. MULLER
Superintendent Roll Dept.
Inland Steel Co.
Indiana Harbor Works
East Chicago, Ind.

. . . . Inland successfully combined rolling of wide flange beams with the units that comprised their standard mill facilities . . . . modernization of existing 28-in. structural mill has been completed and procedures developed for producing salable sections . . . . methods of rolling and roll design were interwoven with the mill modernization program . . . .

▲ THE rising demand for wide flange beams, particularly in the lighter foot weights, is the result of architectural trends and requirements of the construction industry. Expansion and growth of industry accompanied by new construction are additional factors which create a demand for this type of structural shape. A few years ago it became apparent to the management of the Inland Steel Co. that another wide flange beam mill would find a market in the Chicago area. Following market research and an economic study, a project involving the revamping and modernization of a 28-in. structural mill was approved in June 1954. At that time, the 28-in. mill was rolling only standard shapes, rails, bars and miscellaneous shapes.

The method of rolling and roll design became interwoven with the mill modification planning from the beginning. Several decisions relating to the product had to be made at the outset because of factors affecting mill layout and engineering. It was decided to produce only parallel flange beams, with no taper on the inside of the flanges, because of greater acceptability by the trade. A comparison of two wide flange beam rolling methods in use in the United States for over 30 years, is shown by Figures 1 and 2.

The major difference in the methods is that the method of Figure 1 rolls with flanges flared and finishes with no flange taper while the method of Figure 2 rolls with straight flanges and finishes with approximately 3 degrees taper on the inside of the flange.

Both mills using these methods employ two reversing stands. Because of the additional expense for a second stand, we were desirous of avoiding two reversing universal stands. We realized, too, that if we planned on too many passes for one universal mill we would have a production bottleneck. Initially we thought of using the 28-in. mill three-high roughing stand for but one pass. After further consideration, we decided to lay out as many sections as possible with three passes in the 28-in. mill rougher using the tongue and groove method of rolling to preform the blank going to the 44-in. universal mill. Figure 3 shows diagrammatically how the composite 46-in. bloomer—28-in. mill unit is set up for rolling standard structural sections. The circle indicates the stand retained for preliminary work in rolling wide flange beams. Figure 4 shows how the combined rolling units look when set up for rolling wide flange beams. Section size limitations for the mill were fixed by depth and flange width. The width of roll available in the 32-in. mill (78-in. body) and the width of approach table limits the section depth to 24 in. It was estimated that a flange width of 12 in. would be the maximum that the rolls of the 32-in. mill could develop safely from a strength standpoint with the roll diameters available. Experience has proven these premises correct. Twelve-in. flanges have demonstrated critical boundary properties. Thus, the universal stands and other equipment were engineered with the 24-in. depth and 12-in. flange width limitation in mind.

It was decided to prepare rolls for the following sections to be rolled during the initial period. Additional

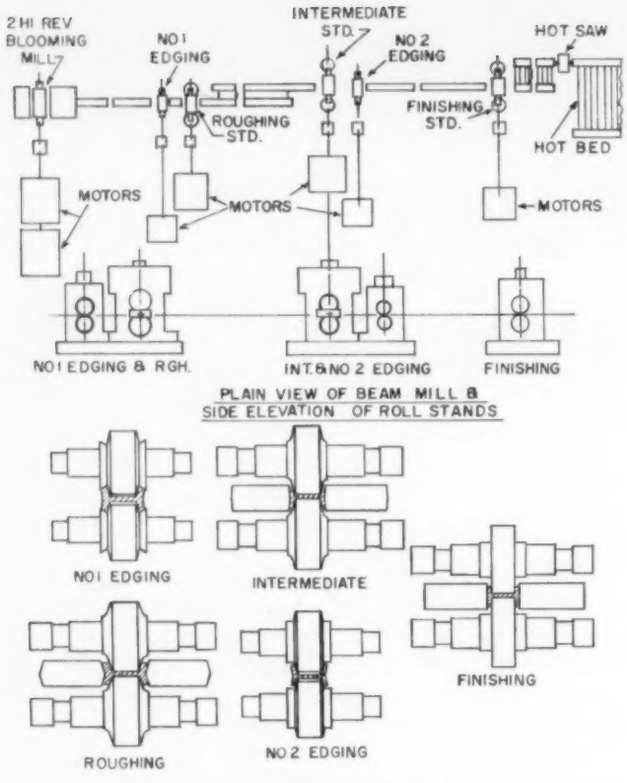


Figure 1 — This method of rolling wide flange beams rolls with the flanges flared and finishes with no flange taper.

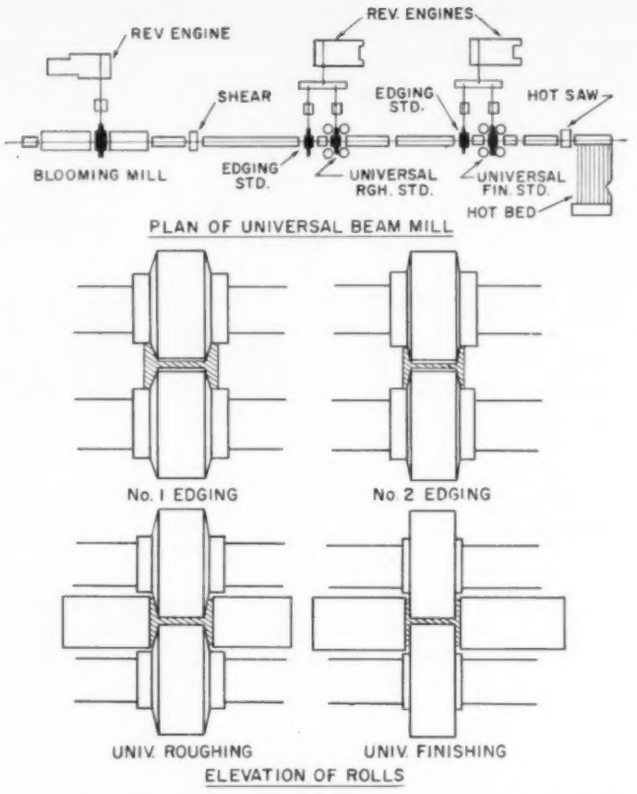


Figure 2 — This method of rolling wide flange beams rolls with straight flanges and finishes with a three-degree taper on the inside of the flange.

sections within the capabilities of the mill were to be added later as follows:

$8 \times 5\frac{1}{4}$ in.
$10 \times 5\frac{3}{4}$ in.
10×4 in.
$12 \times 6\frac{1}{2}$ in.
12×4 in.
$14 \times 6\frac{3}{4}$ in.
16×7 in.
$18 \times 7\frac{1}{2}$ in.
$21 \times 8\frac{1}{4}$ in.
24×9 in.

The designs developed for these sections vary or differ with respect to the following points: (1) use of rectangular bloom or shaped beam blank, (2) the number of grooves or passes in the 32-in. mill, (3) the number of passes in the 28-in. mill, and (4) the number of passes in the universal mill.

It was apparent that a high production rate must be

Figure 3 — Mill setup for rolling standard structural sections on composite 46-in. bloomer—28-in. mill.

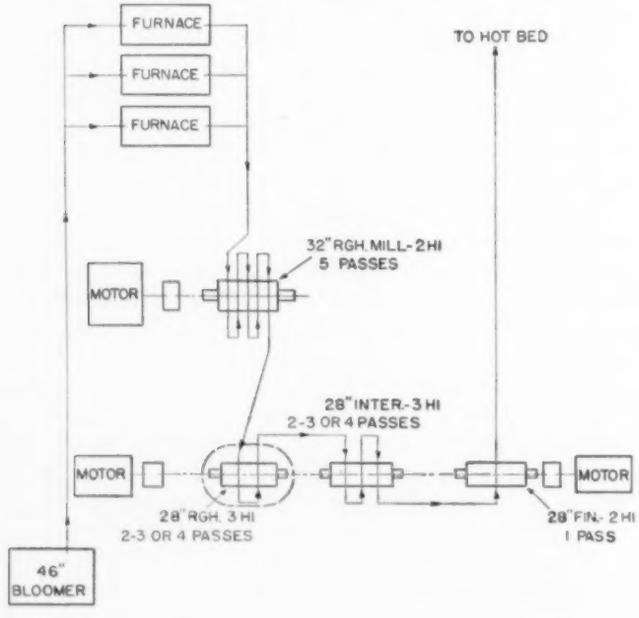
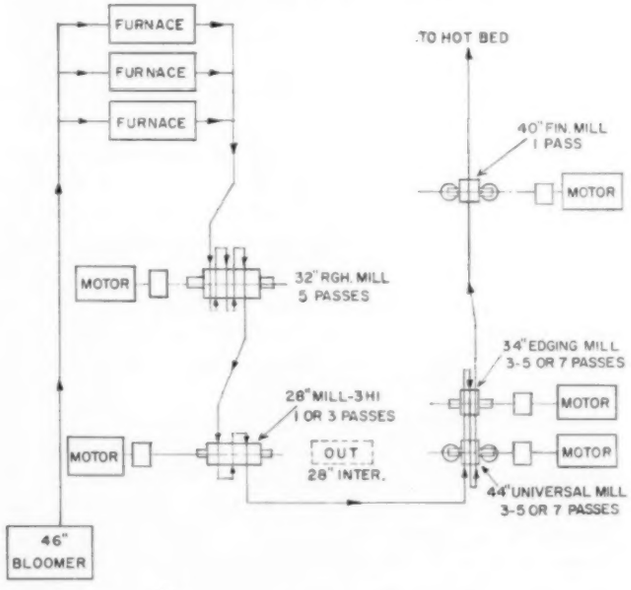
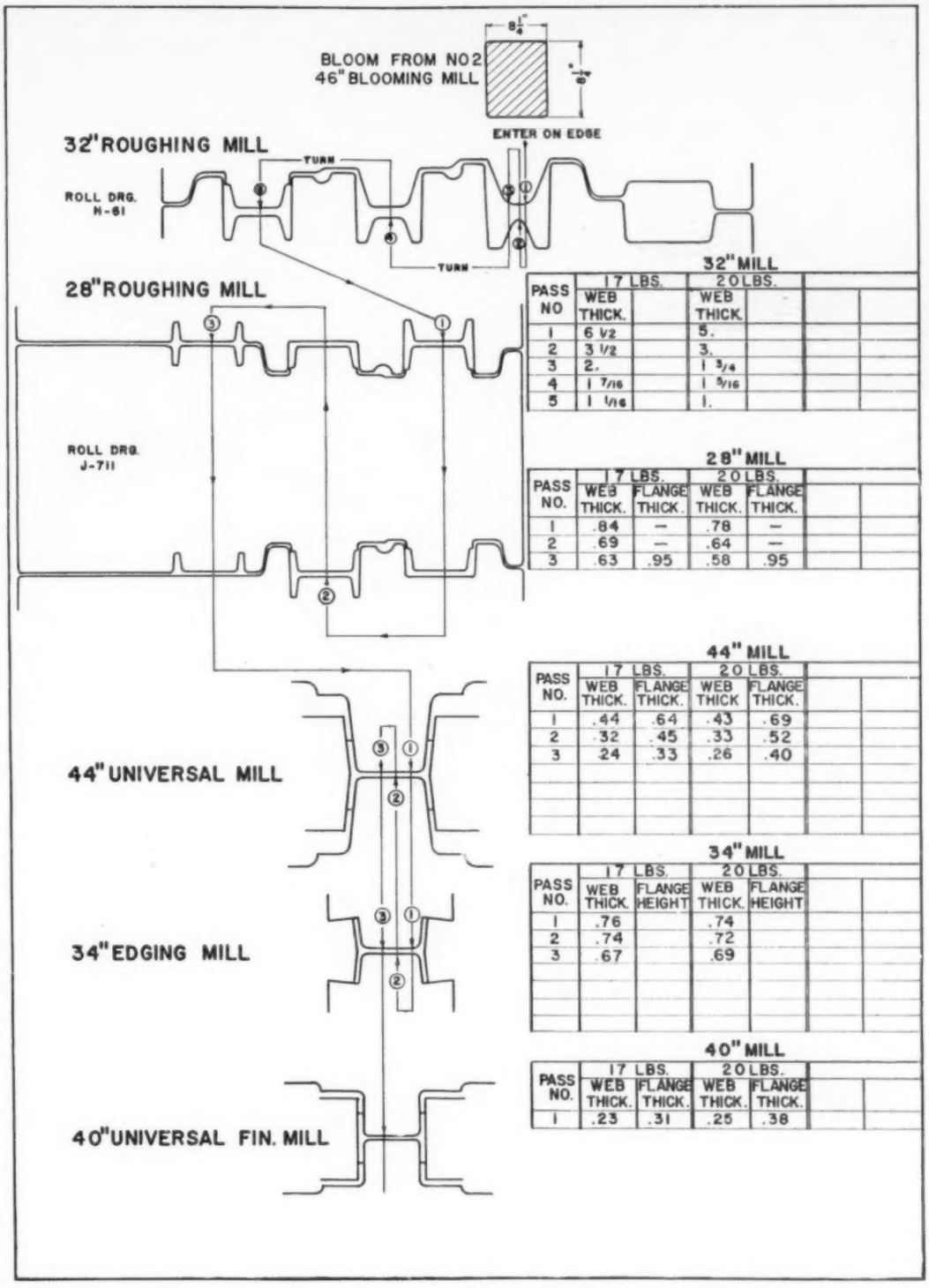


Figure 4 — Setup for rolling wide flange beams.





32" MILL

PASS NO	17 LBS. WEB THICK.		20 LBS. WEB THICK.			
1	6 1/2		5.			
2	3 1/2		3.			
3	2.		1 3/4			
4	1 7/16		1 5/16			
5	1 1/16		1.			

28" MILL

PASS NO.	17 LBS. WEB THICK.	17 LBS. FLANGE THICK.	20 LBS. WEB THICK.	20 LBS. FLANGE THICK.		
1	.84	—	.78	—		
2	.69	—	.64	—		
3	.63	.95	.58	.95		

44" MILL

PASS NO.	17 LBS. WEB THICK.	17 LBS. FLANGE THICK.	20 LBS. WEB THICK	20 LBS. FLANGE THICK.		
1	.44	.64	.43	.69		
2	.32	.45	.33	.52		
3	.24	.33	.26	.40		

34" MILL

PASS NO.	17 LBS. WEB THICK.	17 LBS. FLANGE HEIGHT	20 LBS. WEB THICK.	20 LBS. FLANGE HEIGHT		
1	.76		.74			
2	.74		.72			
3	.67		.69			

40" MILL

PASS NO.	17 LBS. WEB THICK.	17 LBS. FLANGE THICK.	20 LBS. WEB THICK.	20 LBS. FLANGE THICK.		
1	.23	.31	.25	.38		

Figure 5 — Pass schedule for rolling 8 x 5¼-in. wide flange beams on 44-in. structural mill.

obtained on the lighter sections because of an expected concentration of orders in these sizes. Consequently, we strove to balance the rolling time between the various stands.

Figures 5, 6 and 7 compare three typical layouts in use at the present time.

The layout shown for the 8 × 5¼ in. on Figure 5 is also applied to the 10-in., 12-in., and 14-in. sections. Characteristically it calls for a rectangular bloom entering the 32-in. mill, five passes in the 32-in. mill, three passes in the 28-in. mill rougher, three passes in the universal mill, and one pass in the 40-in. universal finishing mill. Except for the 14-in. section, which is a little slow rolling in the 32-in. mill, this layout affords a very good rolling time balance in the three major rolling units. The maximum rolling rate on this combination has not been fully explored. The present record is held by the 12 × 6½-in. section at 960 tons per turn with a best hour of 148 tons. Present limitations to production are not in the rolling units but in furnace heating capacity and finishing facilities.

The 16 × 7-in. section shown by Figure 6 is the smallest requiring a blank from the 46-in. blooming mill. Its layout is characterized by rolling over in passes 1 and 2 in the 28-in. mill. This is the largest section for which three passes are taken in the 28-in. mill.

The heavier sections, of which the 24 × 9-in., shown by Figure 7, is typical, all take a beam blank from the

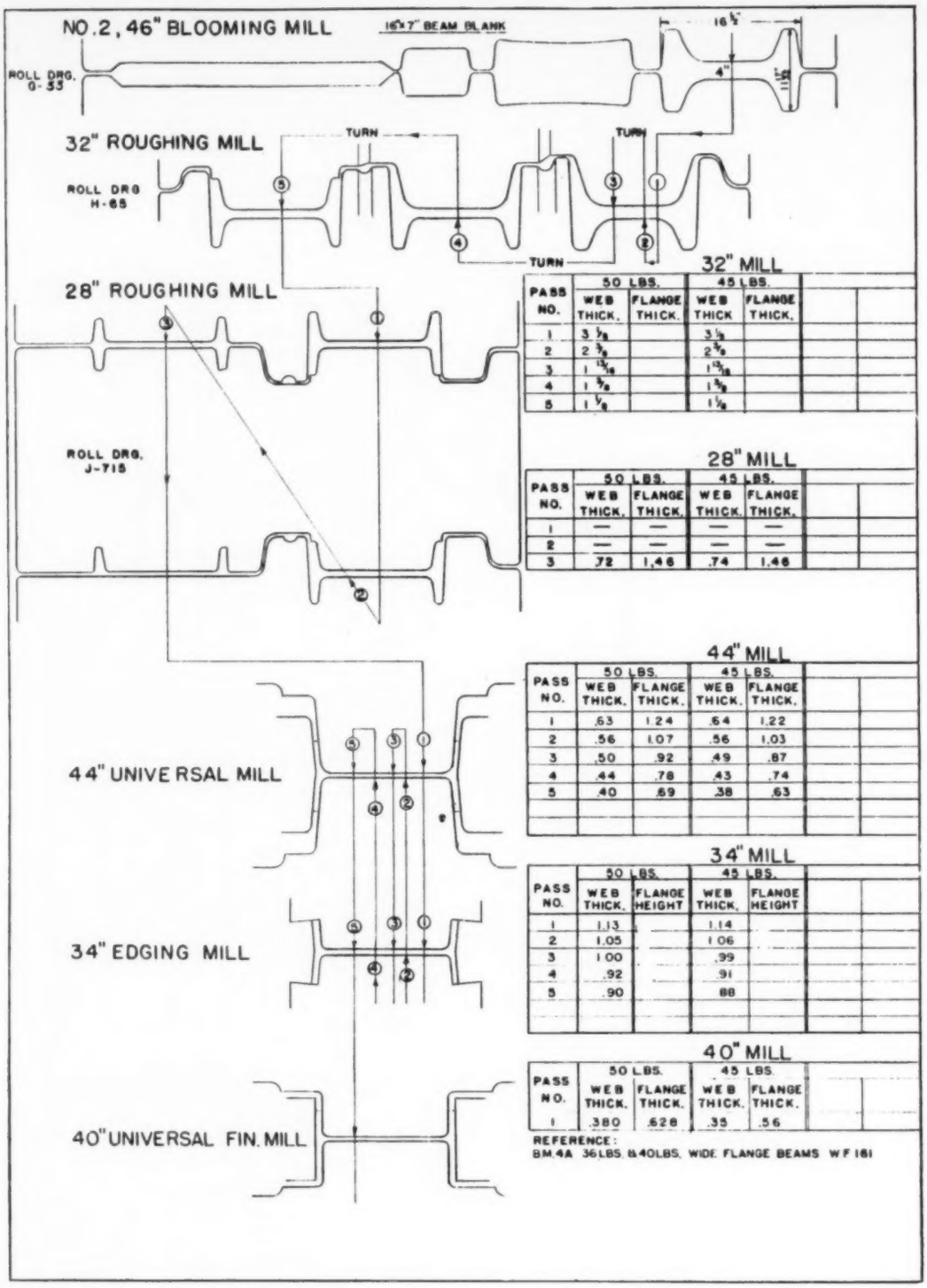
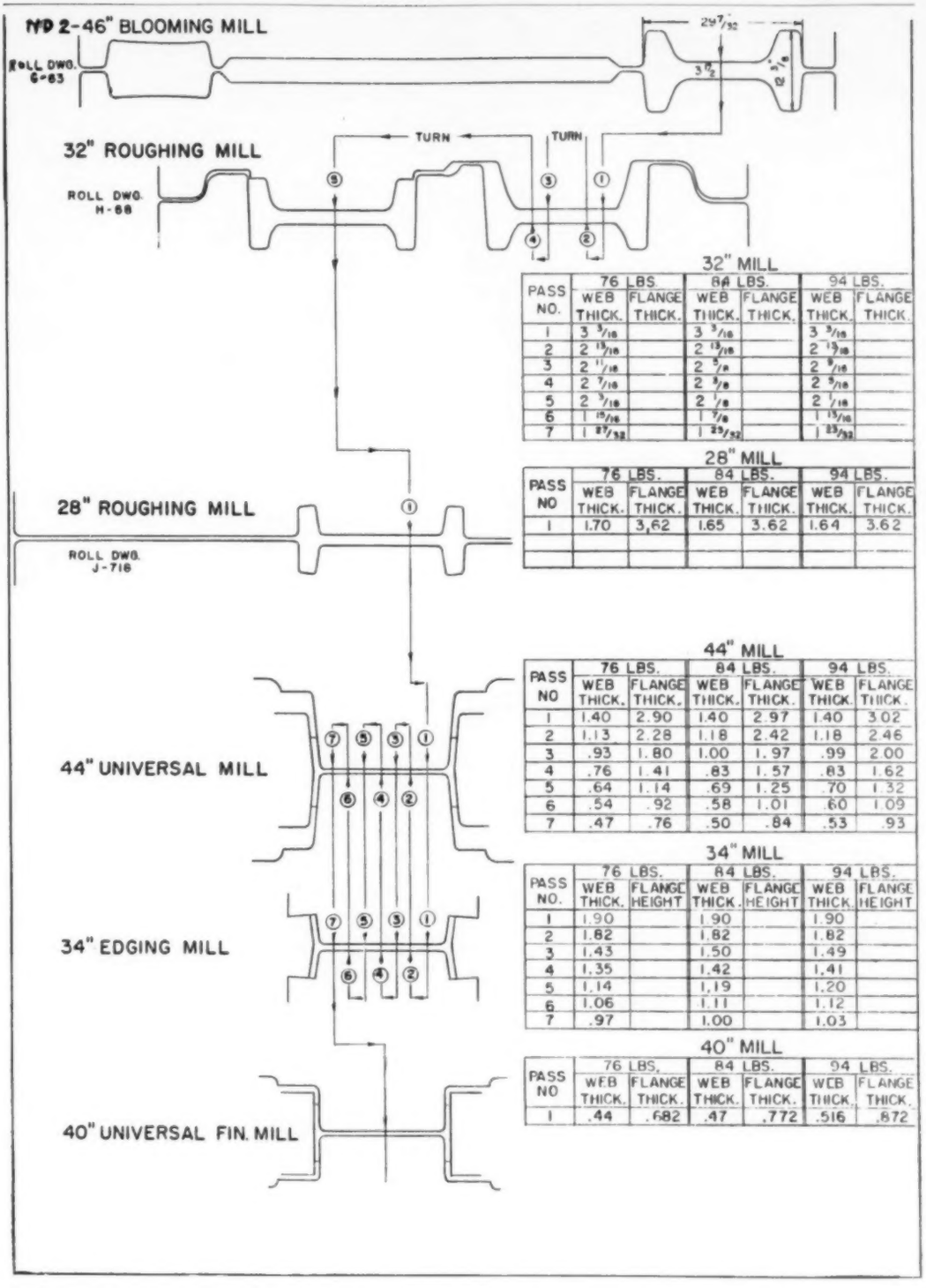


Figure 6 — Pass schedule for rolling 16 x 7-in. wide flange beams on 44-in. structural mill.

46-in. blooming mill, five passes in the 32-in. mill, and one pass in the 40-in. universal finishing mill. We have found from experience that we cannot take more than five passes in the 32-in. mill without imposing a production block. A beam blank from the blooming mill and good heating is essential. The single pass in the 28-in. mill serves to equalize flanges. Very little web work is done. We are pleased with the functional aspect of this pass. Unequal flanges and off-center webs have never been a problem. We have tried both five-pass and seven-pass schedules in the 44-in. universal mill. We found that the seven-pass schedule is more satisfactory from a quality standpoint. There is less tendency to buckle or upset flanges because of excess edging work. Seven-pass schedules have not slowed production because presently there are other limitations. In the future we may be forced to consider five-pass schedules again in order to balance the rolling time between the various stands. At present the 32-in. mill and 44-in. mill seem to be in balance. Quicker manipulation and faster screw-down action on the 32-in. mill could change this picture. The production record in this group of sections is 1127 tons per turn on the 24 × 9-in. size.

DESIGN PROCEDURES

In the foregoing was described the general methods of rolling. One of the first steps in the design work is to



32" MILL

PASS NO.	76 LBS. WEB THICK.	76 LBS. FLANGE THICK.	84 LBS. WEB THICK.	84 LBS. FLANGE THICK.	94 LBS. WEB THICK.	94 LBS. FLANGE THICK.
1	3 3/16		3 3/16		3 3/16	
2	2 13/16		2 13/16		2 13/16	
3	2 11/16		2 5/8		2 5/8	
4	2 7/16		2 5/8		2 5/16	
5	2 3/16		2 1/8		2 1/16	
6	1 15/16		1 7/8		1 15/16	
7	1 27/32		1 23/32		1 23/32	

28" MILL

PASS NO	76 LBS. WEB THICK.	76 LBS. FLANGE THICK.	84 LBS. WEB THICK.	84 LBS. FLANGE THICK.	94 LBS. WEB THICK.	94 LBS. FLANGE THICK.
1	1.70	3.62	1.65	3.62	1.64	3.62

44" MILL

PASS NO	76 LBS. WEB THICK.	76 LBS. FLANGE THICK.	84 LBS. WEB THICK.	84 LBS. FLANGE THICK.	94 LBS. WEB THICK.	94 LBS. FLANGE THICK.
1	1.40	2.90	1.40	2.97	1.40	3.02
2	1.13	2.28	1.18	2.42	1.18	2.46
3	.93	1.80	1.00	1.97	.99	2.00
4	.76	1.41	.83	1.57	.83	1.62
5	.64	1.14	.69	1.25	.70	1.32
6	.54	.92	.58	1.01	.60	1.09
7	.47	.76	.50	.84	.53	.93

34" MILL

PASS NO.	76 LBS. WEB THICK.	76 LBS. FLANGE HEIGHT	84 LBS. WEB THICK.	84 LBS. FLANGE HEIGHT	94 LBS. WEB THICK.	94 LBS. FLANGE HEIGHT
1	1.90		1.90		1.90	
2	1.82		1.82		1.82	
3	1.43		1.50		1.49	
4	1.35		1.42		1.41	
5	1.14		1.19		1.20	
6	1.06		1.11		1.12	
7	.97		1.00		1.03	

40" MILL

PASS NO	76 LBS. WEB THICK.	76 LBS. FLANGE THICK.	84 LBS. WEB THICK.	84 LBS. FLANGE THICK.	94 LBS. WEB THICK.	94 LBS. FLANGE THICK.
1	.44	.682	.47	.772	.516	.872

Figure 7 — Pass schedule for rolling 24 x 9-in. wide flange beams on 44-in. structural mill.

circumscribe the method; that is, fix the number and type of passes in each stand arbitrarily. As in other roll design work, the starting point for the designer is the finished bar and last pass, keeping in mind the type of bar delivered from the various stands, and considering physical limitations. The procedure can be outlined as follows:

40-INCH UNIVERSAL FINISHING MILL

Decide on maximum width and minimum width of horizontal roll based on estimated shrinkage rate and permissible tolerances—Figure 8 shows a work sheet for determining web widths. Naturally, one would like to start these rolls as large as possible, yet being able to roll within published tolerances. The interpretation put on the shrink rate is that it is purely an arbitrary figure for design purposes. We prefer to estimate it (in the case of wide flange beams) a little lower in order to be on the safe side should cold bars be rolled. In order to check ourselves, we obtain mill reports after each rolling and then make adjustments in order to realize the maximum tonnage from the rolls.

ROLL DESIGN FOR 44-INCH UNIVERSAL MILL

Determine maximum width the horizontal rolls may be turned to—(The taper on the sides, 6 degrees, has pre-

SECTION NUMBER	NOMINAL DEPTH	FLANGE THICK.	W_c INSIDE WEB WIDTH (COLD)	SHRINK. RATE	T OVER TOLERANCE	S TOTAL SHRINK.	W_H INSIDE WEB WIDTH (HOT)
WF 81	8.000	.308	7.384	.007	.125	.055	7.564
WF 161	16.000	.503	14.994	.007	.125	.104	15.223
WF 241	23.910	.682	22.546	.010	.125	.216	22.887

$W_H = W_c + T + S$

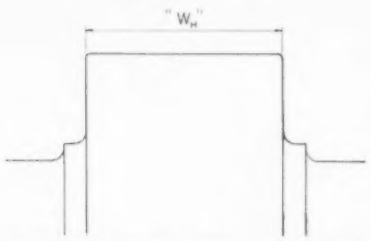


Figure 8 — Data used for determining web widths of 40-in. finishing rolls.

SECTION NUMBER	MINIMUM WEB WIDTH 40" FIN. HOR. ROLL	W_H MAXIMUM WEB WIDTH 40" FIN. HOR. ROLL	S MAXIMUM SPREAD 44" UNIV MILL TO 40" FIN MILL	"W" MINIMUM WEB WIDTH 44" UNIV MILL	"W" MAXIMUM WEB WIDTH 44" UNIV MILL
WF 81	7.346	7.564	.109	7.237	7.564
WF 161	15.005	15.223	.171	14.834	15.223
WF 241	22.669	22.887	.171	22.498	22.887

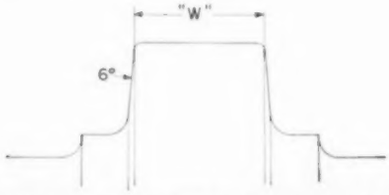


Figure 9 — Data used to determine web widths of 44-in. mill horizontal rolls.

SECTION NUMBER	NOMINAL FLANGE WIDTH COLD	WEB THICK	NOMINAL LENGTH FROM WEB (COLD)	SHRINK FACTOR	"A" NOMINAL LENGTH HOT	"B" CLEARANCE ONE SIDE LAST PASS	"C" MAXIMUM UNDER TOLERANCE	"D" PASS DEPTH
WF 81	5.250	.230	2.510	1.008	2.530	.093	125	2.312
WF 161	6.992	.299	3.347	1.010	3.380	.124	125	3.131
WF 241	8.985	.440	4.273	1.011	4.320	.374	125	3.821

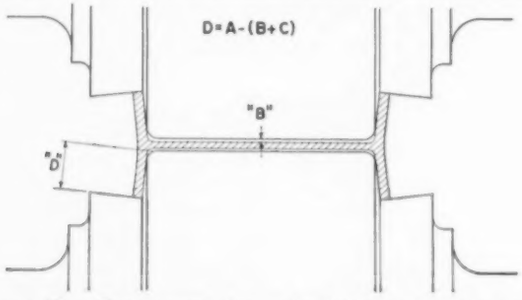


Figure 10 — Data used for calculating depth of pass of edging roll.

viously been determined the same for all sections.) Figure 9 shows a work sheet for determining these web widths. It is advantageous, from a roll life standpoint, to start as large as possible. There is more leeway on these widths than the 40-in. mill widths, inasmuch as there is some mismatching permissible between the 44-in. and 40-in. mills. In the beginning we turn 44-in. mill rolls the same width as 40-in. mill rolls. Thereafter the 44-in. mill rolls may be the same or narrower up to the maximum spread noted on Figure 9. We never permit the 44-in. mill rolls to be wider than the 40-in. mill rolls.

Calculate a drafting schedule for the 44-in. universal mill—In our method drafting is calculated on surface draft alone. Table I shows a work sheet for calculating drafts. Area relationships are disregarded. By overdrafting the flanges from 1 per cent to 5 per cent, web buckles are avoided and spreading of the flanges is induced. Extremely heavy drafts must be avoided in the universal mill because of the possibility of an entering problem at the vertical rolls. The drafting schedule for this mill and the 34-in. edger is set up on a preset board and the pass sequence is an automatic push-button operation from thereon.

TABLE I

Drafting Calculations for 24-in. x 9-in WF 241

94-lb Section

	Web	Reduction, per cent	Flange	Reduction, per cent	Difference between web and flange reductions, per cent
Pass No. 1 28-in. mill	1.64		3.62		
Pass 1	1.40	14.6	3.02	16.5	1.9
2	1.18	15.7	2.46	18.5	2.8
3	0.99	16.1	2.00	18.6	2.5
4	0.83	16.1	1.62	19.0	2.9
5	0.70	15.6	1.32	18.5	2.9
6	0.60	14.2	1.09	17.4	3.2
7	0.53	11.6	0.93	14.6	3.0
Finishing	0.51	3.7	0.872	6.2	2.5
Total reduction, per cent		68.5		75.9	7.4

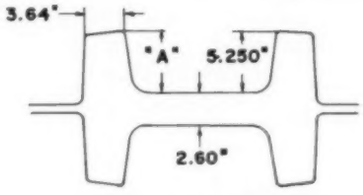
84-lb Section

	Web	Reduction, per cent	Flange	Reduction, per cent	Difference between web and flange reductions, per cent
Pass No. 1 28-in. mill	1.65		3.62		
Pass 1	1.40	15.1	2.97	17.9	2.8
2	1.18	15.7	2.42	18.5	2.8
3	1.00	15.2	1.97	18.5	3.3
4	0.83	17.0	1.57	20.3	3.3
5	0.69	16.8	1.25	20.3	3.5
6	0.58	15.9	1.01	19.2	3.3
7	0.50	13.7	0.84	16.8	3.1
Finishing	0.47	6.0	0.772	8.1	2.1
Total reduction, per cent		71.5		78.7	7.2

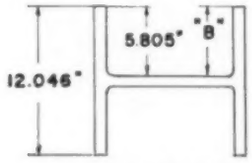
76-lb Section

	Web,	Reduction, per cent	Flange	Reduction, per cent	Difference between web and flange reductions, per cent
Pass No. 1 28-in. mill	1.70		3.62		
Pass 1	1.40	17.6	2.90	19.8	2.2
2	1.13	19.2	2.28	21.3	2.1
3	0.93	17.6	1.80	21.0	3.4
4	0.76	18.2	1.41	21.6	3.4
5	0.64	15.7	1.14	19.1	3.4
6	0.54	15.6	0.92	19.2	3.6
7	0.47	12.9	0.76	17.3	4.4
Finishing	0.44	6.3	0.682	10.2	3.9
Total reduction, per cent		73.3		81.2	7.9

PASS NO.	FLANGE PASS SETTING 44" MILL	FLANGE DRAFT	SPREAD	BAR WIDTH LEAVING 44"MILL 13.100	EDGER SETTING	EDGER WORK IN INCHES
1	2.80	.84	.84	13.940	12.440	1.500
2	2.06	.74	.74	12.930	12.190	.250
3	1.50	.56	.56	13.490	12.490	1.000
4	1.05	.45	.45	12.690	12.240	.250
5	.75	.30	.30	12.990	12.240	.750
6	.59	.16	.16	12.150	11.990	.250
7	.48	.11	.11	12.260	11.859	.401
FIN.	.436	.04	.04			



28" MILL SIZING PASS



FINISHED PROFILE

Figure 11 — Here spread is estimated equal to flange draft.

ROLL DESIGN FOR 34-IN. MILL

Determine the distance across face of the rolls—Normally the face dimension is kept about the same as the 44-in. mill.

Determine the depth of groove—Figure 10 shows a calculation schedule for edging rolls. It should be observed that the clearances increase for the larger sections. These are prone to web buckling. Flanges must be kept short in the early passes to allow for the spread induced by required overdrafting. No contact between the roll face and the web can be permitted lest the circuit breakers trip due to motor overload.

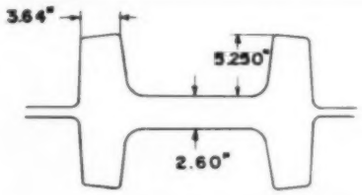
ROLL DESIGN FOR 28-IN. MILL

The pass design in the 28-in. mill is necessarily of the conventional tongue and groove type. There are several problems involved. One is to determine the length of flange 28-in. mill pass. Flange thickness, of course, is determined by the drafting schedule but flange length must be determined by estimation or calculation. We have used both methods. Simple logic is the best tool. If the depth of the 28-in. mill flange pass measured from web to flange tip is as great as the finished minimum flange, a satisfactory bar can be rolled, assuming that normal spreading is rolled off in the edging passes.

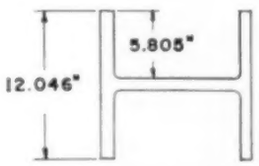
Referring to Figure 11 one must conclude that dimension "A" must be in the range of equal to "B" or less. When flange spreading is greater, due to overdrafting the flanges, it is necessary to hold the edging rolls together in the earlier passes because there is a limit to the amount of edging work that can be done to shorten

PASS NO.	FLANGE PASS SETTING 44" MILL	FLANGE DRAFT	SPREAD	BAR WIDTH LEAVING 44"MILL 13.100	EDGER SETTING	EDGER WORK IN INCHES
1	2.80	.84	.42	13.520	12.440	1.080
2	2.06	.74	.37	12.560	12.190	.250
3	1.50	.56	.28	12.840	12.490	.350
4	1.05	.45	.23	12.470	12.240	.250
5	.75	.30	.15	12.620	12.240	.380
6	.59	.16	.08	12.070	11.990	.250
7	.48	.11	.06	12.130	11.859	.271
FIN.	.436	.04	.02			

Figure 12 — Here spread is estimated equal to one-half flange draft.



28"MILL SIZING PASS



FINISHED PROFILE

PASS NO.	FLANGE PASS SETTING 44" MILL	FLANGE DRAFT	SPREAD	BAR WIDTH LEAVING 44"MILL 13.100	EDGER SETTING	EDGER WORK IN INCHES
1	2.80	.84	1.68	14.780	12.440	2.340
2	2.06	.74	1.48	13.670	12.190	.250
3	1.50	.56	1.12	14.790	12.490	2.300
4	1.05	.45	.90	13.140	12.240	.250
5	.75	.30	.60	13.740	12.240	1.500
6	.59	.16	.32	12.310	11.990	.250
7	.48	.11	.22	12.530	11.859	.671
FIN.	.436	.04	.08			

Figure 13 — Here spread is estimated equal to two times flange draft.

flanges when the flanges are thin. For this reason "A" is generally less than "B". When designing rolls for the wider (12-in.) flange sections, we exploit spreading as much as possible because the roughing holes must be kept shallow in order to strengthen the 28-in., 32-in. and 46-in. mill rolls.

The flange spread from the sizing pass in the 28-in. mill to the finished bar can be formulated mathematically, but the process becomes so complicated and time comsuming in solution that an empirical method is quicker and equally satisfactory. Using the empirical method, one assumes that the spread is equal to the draft for each pass except the last pass. The last trip through the edger is arbitrarily set at the minimum tolerance dimension for a finished bar. The assumption is that the spread in the finisher will bring the flange width within tolerance between maximum and minimum. Figure 11 illustrates a work sheet using this method. The edging work is the variable controlled by the designer and the amount of spread is estimated.

Let us assume that the estimated spread is in error as much as 100 per cent with the edger settings given and test the practicability of the method. It can be seen from the work sheet, Figure 12 which assumes the spread at only one-half the draft, that the only effect of the error in estimate is to decrease the edger work in the odd numbered passes 1, 3, 5 and 7.

Figure 13, which assumes the spread at twice the draft, illustrates the effect of underestimating the spread which is to increase the edger work in passes 1, 3, 5 and 7. The effect of a bad estimate of spread could result in one of the following undesirable effects.

1. Insufficient edging work resulting in short or unfinished flanges.
2. Too much edging work resulting in flange upsetting and flange buckles.

In practice, we tend to overestimate the spread of deep flange sections, the flanges of which are induced to spread. The edging passes serve to even out deviations. Essential to this phase of design is to provide for keeping the flanges short in the earlier edging passes, avoiding heavy edging work in the later passes. This demands sufficient allowance for web clearance at the edger.

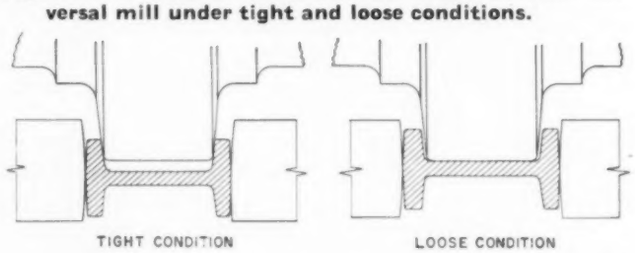
In the three-pass layout on the 28-in. mill three-high set, passes No. 1 and No. 2, which are tongue and groove, are designed to work the flanges hard and effect a substantial reduction in inside flange taper in each pass except the last or third pass. Web spread is allowed as large as possible in each succeeding pass. This has the effect of narrowing the land on the tongue facilitating cutting in the earlier passes.

The relationship between the 28-in. mill last pass (the equalizing groove) and the width of the 44-in. mill horizontal roll is not a constant one. After successive dressings, the 44-in. mill rolls are narrower, (within a range of 0.389 in.). The significance of this is that bars from the 28-in. mill will enter the first pass of the 44-in. mill from tight to loose across the web. This has not caused any trouble thus far. It is conceivable that if too much looseness develops, laps may be encountered at the fillets. Figure 14 shows the effects of tightness or looseness when entering the 44-in. mill.

ROLL DESIGN FOR 32-INCH MILL

The 32-in. mill roll design is conventional tongue and groove. Rapid flange development is a function of these passes. In order to insure freedom from overfills no flange stops are used. Flanges are drafted heavily so that

Figure 14 — Sketches compare bars entering 44-in. universal mill under tight and loose conditions.



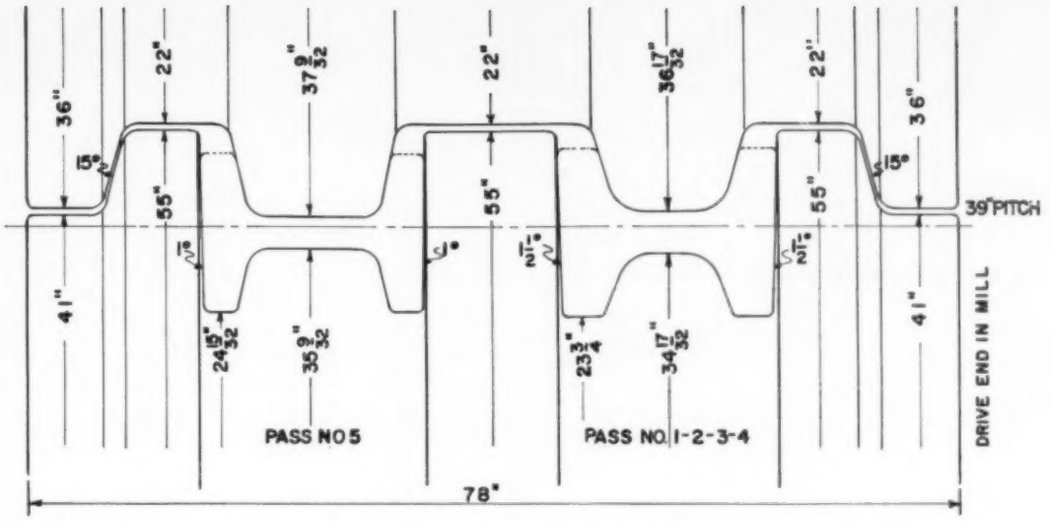


Figure 15 — 32-In. roughing mill rolls used for 12 x 12-in. bearing pile section.

a more open forming pass in the blooming mill rolls is possible, resulting in fewer passes to bring the flanges up in the blooming mill.

The number of grooves which can be turned in the 32-in. mill rolls, (78-in. face) vary with section size. The 21-in. and 24-in. beams permit but two grooves. Four passes are taken in the first groove; one pass in the second groove. Because this is a motor driven screwdown mill equipped with double manipulators, there is latitude for discretion and judgment on the part of the roller in determining pass settings and turning the bar. As a rule we do not change the instruction sheet to reflect actual mill practice, because we find that if trouble develops, a return to scheduled practice rectifies the difficulty. For example, some rollers, in order to save time, may not turn the bar 180 degrees as often as prescribed. While this practice may aid production, we do not go on record as condoning it. All passes in the 32-in. mill are ragged or knurled. The first groove is rib ragged and the second or third knurled. This is essential in order to prevent loss of time entering the bar due to slippage. The nominal 32-in. pitch of this mill has been raised to 38 in. or 39 in. to strengthen rolls weakened by deep flange grooves and collar recesses. At times we have moved passes off pitch in order to strengthen a weak top roll. We specify a very mild alloy steel roll for this application in order to minimize roll breakage. To illustrate the extremes of diameter, Figure 15 shows a 32-in. mill roll for 12 × 12-in. bearing pile section. Note the 55-in. collar diam of the bottom roll and 22-in. recess diam of the top roll. The section has intentionally been thrown off pitch.

ROLL DESIGN FOR 46-IN. BLOOMER

Since the objective is to roll slabs, blooms, and beam blanks in sequence, the 100-in. roll body must have as few grooves as possible. We decided that we would have but one shape pass and one edging pass and a bullhead portion.

Figure 16 shows the 46-in. blooming mill rolls for 24 × 9-in. section. The deep flange holes were a source of worry from a breakage standpoint, and justifiably, for there has been excessive breakage which we hope to overcome with stronger roll materials. Because it is necessary to line the bottom roll higher in order to be sure of pickup at the bottom of the flanges, it is also necessary to recess the bullhead portion of the roll to decrease the pickup at the bullhead. The drafting schedule indicates edging passes needed for rolling off the overfill which eventually develops at the roll parting from too many forming passes.

Figure 17 shows the blooming mill drafting schedule for wide flange beams. Whenever our mill observations indicate the need, we make roll alterations to improve sections and productivity. It is important that the roller

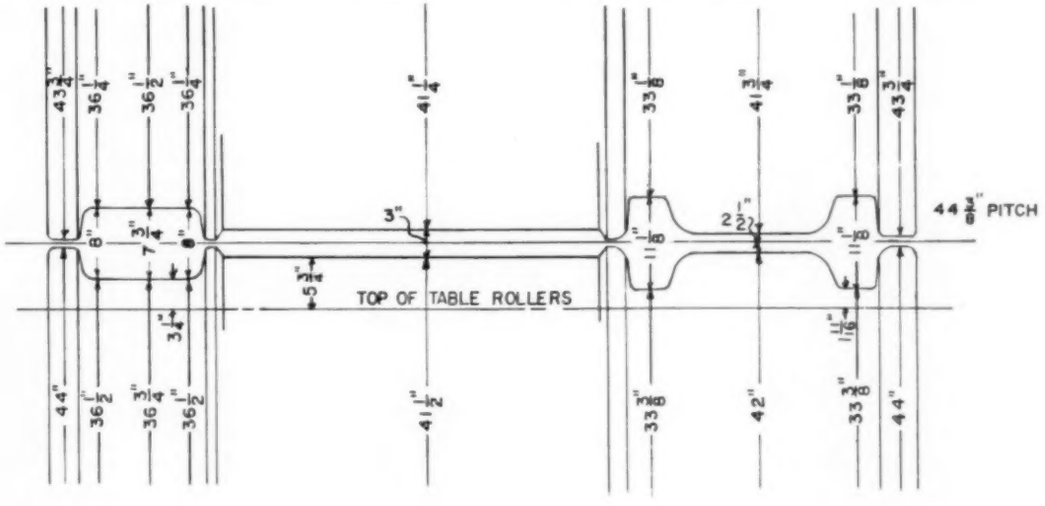


Figure 16 — 46-In. blooming mill rolls used for 24 x 9-in. wide flange sections.

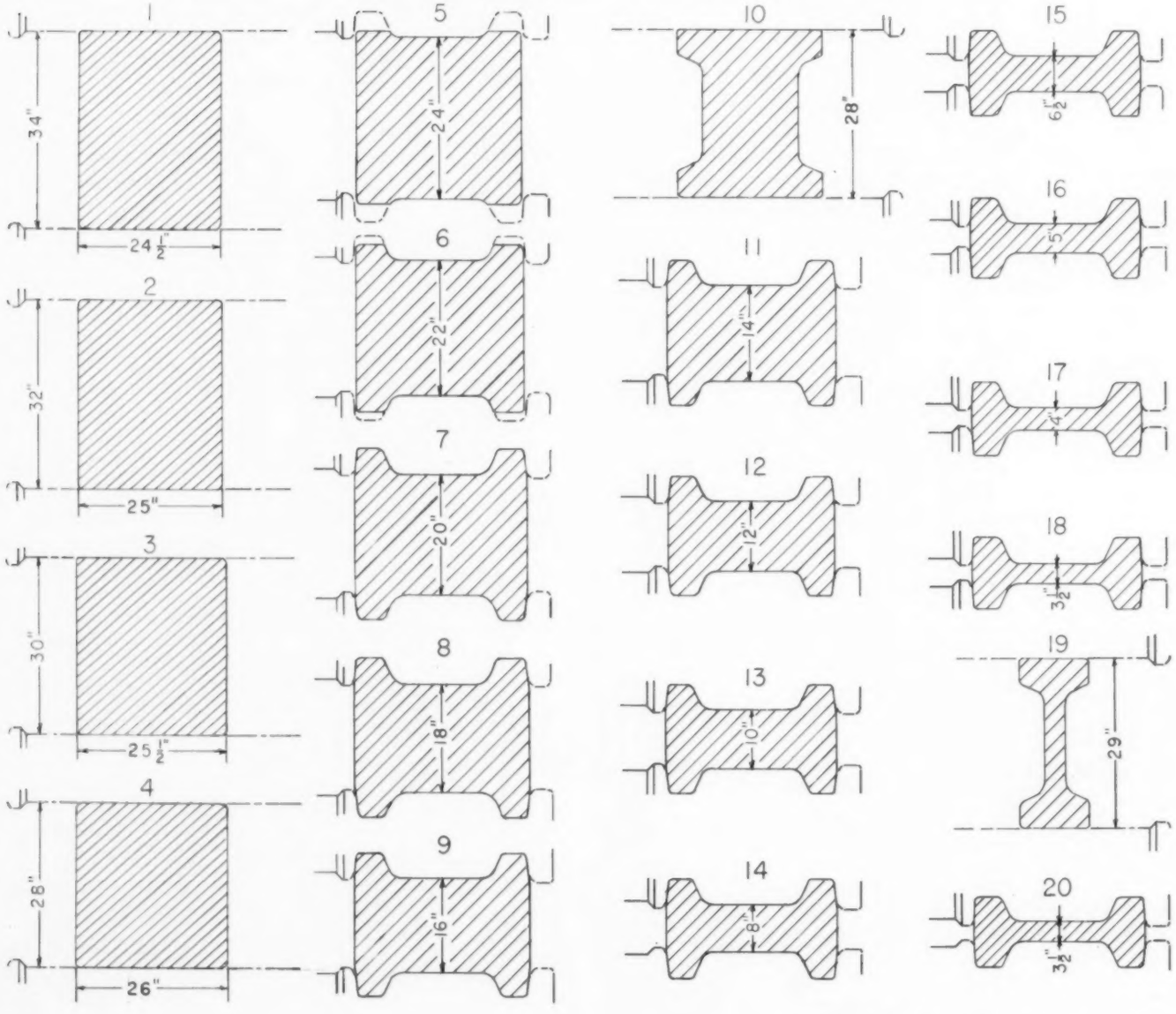
and his crew do not have to spend time fighting buckles, long or short flanges, or a crossed mill. From the beginning we made setup charts to assist in building up rolls, establishing elevations, reference points and gaging positions.

The most important aspect of mill adjustment is to deliver a symmetrical section from the 44-in. mill. At first we cut cobbles from trial bars by gas torch. This was inordinately time consuming. Now, we either open up the finisher, omit the finishing stand and saw a sample piece with the hot saws or check the next to the last 44-in. universal mill pass which can be cobbled on the back table and transferred to the front table.

The roll builder and roller make every effort to adjust

Figure 17 — Drafting schedule used to convert 24 x 36-in. ingots to 24 x 9-in. beam blanks.

PASS NO	POSITION	GROOVE	RED	SIZE OF PASS
1	EDGE	BULLHEAD	2"	24½ x 34"
2	"	"	2"	25" x 32"
3	"	"	2"	25½ x 30"
4	"	"	2"	26" x 28"
5	TURN-FLAT	SHAPE	2"	28" x 24"
6	FLAT	"	2"	28½ x 22"
7	"	"	2"	29" x 20"
8	"	"	2"	29½ x 18"
9	"	"	2"	29½ x 16"
10	TURN-EDGE	BULLHEAD	1½	16¼ x 28"
11	TURN FLAT	SHAPE	2¼	28½ x 14"
12	FLAT	"	2"	29" x 12"
13	"	"	2"	29¼ x 10"
14	"	"	2"	29¼ x 8"
15	"	"	1½	29¼ x 6½
16	"	"	1½	29¼ x 5"
17	"	"	1"	29¼ x 4"
18	"	"	½	29¼ x 3½
19	TURN-EDGE	BULLHEAD	½	3¼ x 29"
20	TURN-FLAT	SHAPE	¼	29" x 3½
21				IDLE



and check the initial mill settings with gages. Gages, however, do not show the actual rolling position of the rolls for many reasons such as mill spring, clearances, etc. An actual trial bar out of the 44-in. mill as well as out of the 40-in. mill is necessary to check the mill adjustment.

Corrections after trial bars can be made on the universal mill by resetting the mill or by changing the preset board, whichever is convenient. Adjustments on the board affect both screws on horizontal or vertical rolls. If it is desired to move one roll only, it is necessary to declutch part of the screwdown mechanism.

Another important reason for checking the first trial bar out of the 44-in. mill is to insure that there is no excess or insufficient work in the 40-in. finishing mill. If one is in doubt about web and flange gages out of the 44-in mill, it is impossible to make sensible adjustments in the 40-in. mill. Furthermore, overdrafting the 40-in. finishing mill can cause serious delays because it is an a-c driven mill which cannot be reversed in case of a sticker.

SUMMARY

We have been very fortunate in being able to produce salable bars upon each trial rolling. Unquestionably experience gained in the first rollings enabled us to make corrective alterations which led to further success on other sections. The now experienced and well trained crews facilitate starting new sections. At the date of this writing, we no longer plan on trial rollings but feel confident enough to go into production rollings from the start.

DISCUSSION

PRESENTED BY

R. W. COUCH, Superintendent Mills and Shipping Yard, Bethlehem Steel Co., Saucon Div., Bethlehem, Pa.

D. E. PETERSON, Assistant Superintendent Roll Shop, South Works, United States Steel Corp., Chicago, Ill.

W. H. BOYLE, Superintendent Merchant & Skelp Mills, Kaiser Steel Corp., Fontana, Calif.

V. W. JOHNSON, Superintendent Blooming & Finishing Mills, The Colorado Fuel and Iron Corp., Pueblo, Colo.

A. F. EISEL, Chief Roll Designer, United Engineering and Foundry Co., Pittsburgh, Pa.

HERMAN E. MULLER, Superintendent Roll Dept., Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

WILLIAM A. GREENE, Assistant Superintendent Plant No. 2 Mills, Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

R. W. Couch: We have been quite interested in hearing of Inland's accomplishments in combining wide flange beam production with units that have comprised their standard mill facilities. The author indicates that flange length must be determined by estimation or calculation, and adds, the "use of simple logic is the best aid toward a solution." It is evident that a good blend of each was used in producing salable bars on each trial rolling.

We would like further comment from Mr. Muller on the following:

1. In Figure 16 we note that the No. 2 blooming mill roll bullhead is recessed. The elevation of the bottom roll above feed rollers would be governed by the depth of the beam blank pass. Is the bullhead recessed entirely because of lift when entering an ingot, or do you consider the recess to be better roll design?

2. Your large collar and pitch diameter sizes, 55 and 39 in. respectively, on the 32 in. mill permitting tongue and groove design should make a good bloom for the 28-in. mill. We also agree that the equalizer pass in the 28-in. mill should eliminate off-center webs being delivered to the 44-in. universal mill. Was the 28-in. mill equalizing pass a part of the original design, or was it added after trial rollings?

3. Do you experience guide trouble in rolling wide flange blooms through your 32-in. and 28-in. mills?

4. In Figure 7, your pass schedule for rolling 24 × 9-in. wide flange beams, pass No. 1 on the 28-in. mill shows a heavier blank for the 76-lb beam than for the 94-lb beam; however, in the first pass for each on the 44-in. mill, the web thickness is the same. What is the reason for this?

5. In your edging mill you specify definite clearance from roll to web for different sections. Is it necessary to adhere strictly to this?

6. In Figure 9, "Determination of web width on the 44-in. horizontal mill rolls," on your WF81 section, how do you arrive at a minimum web width of 7.237 in. on the 44-in. mill, which is less than the minimum 7.346-in. on the 40-in. finishing mill?

7. What limit do you consider desirable for sulphur content in rolling your range of wide flange beams? What is the finish temperature of your wide flange sections? Do you roll your hi-steel or hi-man or other special grades of steel into wide flange sections?

D. E. Peterson: Mr. Muller has given an excellent paper on the roll and pass design for a mill which is unique, in that the product produced, namely a variety of standard structural sections as well as parallel flange beams are rolled. He is to be commended for his efforts in presenting this work to us.

Bethlehem Steel, U. S. Steel at South Chicago, and Homestead, are all producers of wide flange beams. We at South Chicago have a mill consisting of a 54-in. by 120-in. bloomer which rolls blanks for beams, as well as slabs and large billets. The 52-in. beam mill itself consists of universal roughing, intermediate and finishing stands with an edging roll stand in tandem provided at both the roughing and intermediate locations. An odd number of passes are taken at both the roughing and intermediate with one pass in the finishing, all stands being timed to deliver a bar with minimum delay time to the next stand. Product rolled ranges from beams 6 to 36-in. in depth and from 8.5 lb. to 426 lb. per ft.

Buckled webs and wavy flanges have proven troublesome from time to time at South Works but these faults can usually be eliminated by strict compliance with correct drafting practices which insure equal elongation between component parts of the beam.

One of our problems, and I imagine Inland is faced with it also, is the thermal buckle effect which occurs in the web on cooling in the larger sizes of beams, usually 18 in. and over. To alleviate this condition we have tried turning the big beams up on their flanges on the hot bed in order that the webs may be completely enclosed and thus restrict their rate of heat loss. This tends to equalize cooling between web and flange. In addition, through our drafting practice, we attempt to pre-stress the flanges in an effort to eliminate the buckle before it starts.

Although this paper is mainly concerned with roll design on the mill, some discussion by the author on this phase of the operation would be appreciated.

W. H. Boyle: Do you intend to roll H-beams and standard structural sections on your new mill, or do you expect to retain the standards on your old mill?

What would be considered a maximum amount for a rolling of any one section?

What is the maximum tonnage you roll between dressings on the 8-in., 10-in. and 16-in. sizes?

What is the average roll diameter reduction per dressing?

Which stand is the most critical for wear?

Must the horizontal rolls on the 44-in., 34-in. and finishing stands match up for web width? I know you covered this roughly on your 44-in. but how about the 34-in.? Do you know what the maximum difference can be on these standards?

Do you roll different widths consecutively when rolling wide flange beams?

What is the time required for changing from one section to another?

What is the time required to change the standard structural mill to the wide flange mill and vice versa?

V. W. Johnson: We at Colorado Fuel and Iron do not roll wide flange sections, however it is of interest, as wide flange sections is a point that comes up for discussion frequently.

I am interested in what Mr. Boyle asked about the variety of sections that can be made. We are of the opinion that we can throw out an old but good mill for rolling section varieties, replaced with a modern and adequate mill. With too many sections, it could very well be down a large portion of the operating time due to excessive section changes.

I am wondering how that problem fits into this new setup.

A. F. Eisel: In your calculations of web and flange reductions, I agree with you 100 per cent, by disregarding the total area of each pass, considering only the relationship between web and flange reductions.

As you mentioned, flange reductions should be in excess of web reduction, thus keeping the web in tension. Total area of each profile is only necessary for calculating bar lengths between passes.

I have had excellent results with both standard and wide flange beams as well as channels by running the flange reductions up to 7 per cent in excess of web reduction.

In beam and channel designs, the great ratio of flange height to web thickness makes it necessary to reduce the web very rapidly in the breakdown and roughing passes where it is not possible to obtain excess flange reduction. With the web reduced to the desired thickness in these passes, flange height can then be conserved in the intermediate and finishing passes by holding the web drafts to a minimum and maintaining flange reductions 3 to 5 per cent in excess of web drafts.

Herman E. Muller: In considering Mr. Couch's questions one at a time—the first, "Is the bullhead recessed because of lift when entering an ingot, or do you consider the recess to be a better roll design?" As explained in the paper, we recessed the bullhead because of necessity in order to lower the distance to the table. We ordinarily do not like to recess a bullhead on a blooming mill roll because of the possibilities of collar marking a slab or a bloom and because it restricts the width of the bullhead. In addition there is a slight consideration in the extra turning required in the roll shop. The second question asked by Mr. Couch, "Was the 28-in. mill equalizing pass a part of the original design, or was it added after trial rolling?" It was part of the rolling method as originally conceived.

"Do you experience guide trouble in rolling wide flange beams—through your 32-in. and 28-in. mills?" Not to my knowledge. We have used cast alloy steel guides. I have had no complaints on guide performance.

"In Figure 7 your pass schedule for rolling 24-in. by 9-in. wide flange beams, pass No. 1 on the 28-in. mill shows a heavier blank for the 76-lb beam than for the 96-lb beam; however, in the first pass for each on the 44-in. mill the web thickness is the same. What is the reason for this?"

I must compliment Mr. Couch for picking this up because when we issued our rolling schedules, this feature caused consternation. Mill people remarked, "We change to a heavier section but we come down on the mill. The instructions must be wrong." But they were not wrong. The heavier, wide flange beams have a greater flange to web thickness ratio and as this ratio increases we have to increase the ratio in the 28-in. mill. Since we use the same pass for all weights the only controllable variable is the web setting. We cannot change the thickness of the dead hole. Therefore, when we roll heavier beam weights we come down instead of up. It appears to be a paradox.

"In your edging mill you specify definite clearance from roll to web for different sections. Is it necessary to adhere strictly to this?" No, the clearance is determined by cut and try. We provided clearance originally. In some cases we received complaints from the rollers that the edging mill ammeter was starting to swing in the earlier passes. To prevent this we cut more clearance.

"In Figure 9, 'Determination of web width on the 44-in. horizontal mill roll,' on your WF81 section, how do you arrive at minimum web width of 7.237-in. on the 44-in. mill which is less than the minimum 7.346 in. on the 40-in. finishing mill?"

I think this is explained in the paper by allowable spread. We allow spread between the flanges in a range from zero to a maximum. It is possible that we might exceed the amount that we have stipulated as the maximum allowable at times without danger, but we are afraid to take a chance because we know at some point we will start to pull flanges down and experience trouble in the 40-in. mill. Our spreads are arbitrary.

I think that anyone who has a mill like this should take full advantage of spread so as to obtain maximum roll life.

"What limit do you consider desirable for sulphur content in rolling your range of wide flange beams? What is the finish temperature of your wide flange sections? Do you roll your hi-steel or hi-man or other special grades of steel into wide flange sections?" I am not able to answer the first part of the question. I do not think that sulphur has been a problem. I do not know our finishing temperatures precisely. We finish pretty hot in the range of 1500 to 1700 F. We reheat, as you know, and roll through the mill fast. I presume that we finish hotter than the mills who do not reheat.

I do not think that we have rolled any appreciable quantities of high strength steels. If we have, it has been without my knowledge. I know we are not doing this regularly. I will ask Mr. Greene, Assistant Superintendent in charge of our mill, to come up, if he cares to, and make a statement.

William A. Greene: We have not rolled any alloy or low alloy grades of steel in wide flange beams at Inland.

Herman E. Muller: To answer Mr. Boyle's questions, "Do you intend to roll H-beam and standard structural sections on this mill also?"

We are aware of the fact that we can, but presently we have no plans. We are thinking of rolling the six-in. and eight-in. H-beam as wide flange sections with parallel flanges to substitute for the standard H-beams.

"What would be considered a maximum amount for rolling of any one section?" Our limits are variable, on lighter sections, it may be 2000 tons and on heavier sections as high as 5000 tons. We schedule to wear out the roll equipment, if possible.

"What is the maximum tonnage you roll between dressings on the 8-in., 10-in. and 16-in. sizes?" I do not have the figures available at this time but it would vary somewhat between 3000 and 4500 tons. We have changed our limitations at times, because we over-extended ourselves, on pass life.

"What is the average roll reduction per dressing?" Again, this varies as to the position of the roll. The 40-in. finishing verticals are ground. The reductions vary from a $\frac{1}{32}$-in. on diameter to $\frac{1}{16}$-in. It is virtually impossible to predict the diameter reduction on the horizontal rolls because there is no taper on the rolls. Dressing is entirely on the side of the rolls. A light cut is taken on the roll face in order to restore the surface. Dressings on diameter may be $\frac{1}{16}$ in. per side. Dressings vary. Sometimes the roll is in a long time and dressings may exceed the aforementioned.

"Which stand is the most critical for wear?" The 44-in. mill stand is most critical for wear. There are more passes taken here, and the roughness that develops on the 44-in. mill cannot be rolled out on the 40-in. mill.

"Must the horizontal rolls on the 44-in. and 34-in. finishing stands match up for web width?" As I stated in the paper, we try to hold them the same. We have tried difference in the direction of the 44-in. horizontal rolls slightly narrower than the 34-in. edging rolls. We prefer not to permit looseness. The variation has been from $\frac{1}{8}$ in. tight to about $\frac{1}{16}$ in. loose. The flanges tend to bend out if tolerance is too tight.

Our practice is to insert two or three wide flange beam sections in a weekly schedule and space them with other sections such as standard structural, rails or billets. In this way we can build up wide flange beam housings on non-operating turns or when the mill is running. We do not wait for the mills to be built up. The time required to build up is not important inasmuch as it is done without mill delay.

The time required to change the standard structural mill to wide flange and vice versa is determined by the roll change in time on the 32-in. mill. This runs from an hour to an hour and a quarter. I would like to have Mr. Greene correct me if that is wrong.

William A. Greene: Roll changes from standard structural to wide flange or vice versa are taking approximately 1 hour-15 minutes. Roll changes from standard structural to wide flange require the change of a pinion stand as well as housings. This arrangement permits the use of the new 7000-hp motor to drive the 44-in. universal structural mill through a two-high pinion stand on wide flange rollings and to drive the 28-in. mill, intermediate, and finisher housings through a three-high pinion stand on standard structural rollings.

Conventional product, such as—standard structurals, rails, or billets—are rolled on the 28-in. mill while the rolls in the wide flange beam housings are changed at the build-up area. Although the wide flange rolls have been changed in less than eight hours, it is normal practice to provide at least twelve hours of conventional rolling between wide flange rollings to permit the change of the beam mill rolls.

Herman E. Muller: I think that answers the question completely. The build up crew requires twelve hours for a complete build up job.

To answer Mr. Johnson's questions, he asked if schedules are a problem. Schedules are a problem, although they are not our problem (in the roll department). The only time they are our problem is in preparing rolls. There is not much downtime, as has been mentioned. An hour and a quarter roll change, is normal for the mill in changing shape sections.

Mr. Eisel remarked that he agreed with me about neglecting or disregarding area calculations. I would like to emphasize this again. We did not consider area calculation in this design work. The reason for this is that in order to avoid web buckles, the web must be kept in tension at all times while rolling. It is absolutely necessary to overdraft the flanges. This is particularly true of the deeper sections. As you all know, the web is completely constricted in the pass whereas the flange is permitted to spread. If part of the metal is displaced to spread, we know it is not going into elongation. Therefore we must draft the flanges harder.

Mr. Peterson asked about thermal buckles. Yes, we have them and we follow the same practice to minimize them. We have also resorted to cooling the flanges with water ahead of the 40-in. finisher. We do not exactly subscribe to the prestress theory at the finishing stand. It is possible to have a residual buckle. If the web is delivered in slight compression, a thermal buckle will develop more readily than the bar is delivered with the web in tension. We try to have the web in tension at all times. Because of the plastic state of the material we do not think we can keep the prestress in the bar. The steel is pretty hot and such stresses will be relieved almost instantaneously.

Greater

. . . individual generators and electronic regulators provide high speeds—in excess of 4000 fpm —at Steel Company of Canada's new Parkdale works . . . .

▲ THE exact origin of wire drawing, one of the oldest of the metal working crafts, has been lost in the obscurity of history, although many attempts have been made to piece together the evolution of the industry from the meager records of the early manufacturers. For many centuries, wire was produced manually by pulling a rod through a tapered hole pierced in some harder material. Successive reductions were achieved by redrawing the rod through progressively smaller holes until work hardening prevented further reduction. Because relatively short lengths were used, the elongation resulting from each successive reduction did not present a problem.

Mechanical refinements in the design of machines and the use of steam and finally electrical motive power were introduced in the late nineteenth and early twentieth centuries. Steel wire was then being drawn through a die onto a power driven cylinder or block acting as a capstan. The block also provided storage for the finished wire in bundle form, allowed longer lengths to be drawn, and made higher speeds economically feasible.

Early steel wire drawing installations adhered to the idea of drawing one die or hole at a time although a series of blocks was usually driven from a common line shaft, Figure 1. This operating procedure necessitated considerable handling in that after each draft or reduction, the wire bundle was returned to the starting position and redrawn in successive passes until the desired size was attained.

With group-driven equipment of this type, the blocks were driven at fixed speeds. Thus the speeds were limited to the maximum that could be used for the heaviest draft, and a speed penalty resulted when drawing the finish sizes. This penalty was offset, to a degree, by having the individual wire drawer handle more spindles.

A jaw type clutch arrangement was used to engage the block to the common drive shaft. This provided an extremely abrupt start which resulted in limitations to the drafting procedures; exceeding these limitations resulted in excessive wire breakage. Friction clutches were tried, but problems associated with their adjustment and maintenance prevented wide usage.

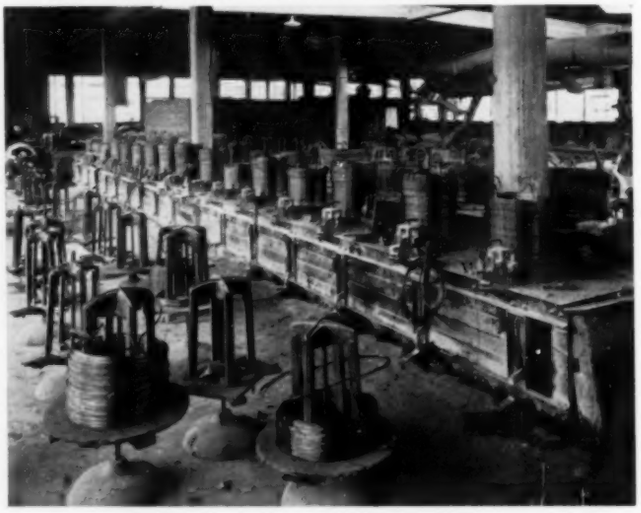
In 1923, after considerable study and research, a motor block was introduced, Figure 2. This was a single spindle block, driven through a worm gear drive by an adjustable-speed shunt-wound d-c motor that received power from the shop supply. Slow starting speeds, relatively smooth acceleration to preset drawing speeds, relatively fast stopping by dynamic braking, and the ability to draw each size at the maximum speed permitted by the power available for the individual block were a few of the operational advantages of this development. A further refinement of this machine provided two-hole continuous drawing by means of a "double deck" block mounted on the single spindle. The block diameters were proportioned to accommodate wire elongation on a fixed percentage basis.

In the early 1930's the introduction of the tungsten carbide die for commercial use elevated the machine speeds twofold. This type of die was harder and thermally permitted operation at higher speeds. Also, at about this time, the welding of rod ends together was developed to a successful commercial degree, thus providing an economical means of making larger bundles and ultimately paving the way for development of continuous drawing machines.

The basic principle of truly continuous nonslip wire drawing requires that the diameter and spindle speed of each block be adjusted to draw the same weight of wire through its die in a given time. Otherwise slipping occurs, or excess wire must be stored on intermediate blocks, and the destruction of coating and consequent scratches on the wire caused by slipping will shorten block and die life. The development of a unit then, which incorporated an individual adjustable speed d-c. motor for each block, was a logical development, Figure 3.

The early units utilized narrow field range motors. The motor fields are set by dancer roll rheostats operated by a loop of wire being drawn between the die and preceding block. The follow motors are controlled from the finishing end, working back successively

Figure 1 — Early wire drawing installation uses a series of blocks driven from a common line shaft.



Flexibility for Wire Drawing

By MAURICE A. NYE
Chief Engineer
The Vaughn Machinery Co.
Cuyahoga Falls, Ohio

and ROBERT C. SUTTLE
Application Engineer
Reliance Electric & Engineering Co.
Cleveland, Ohio

toward the starting end. With this arrangement, the individual block motor speeds are controlled to maintain the dancer roll position, and drafting variables from the geared-in "mean" are automatically compensated for. Wire can be drawn in the same plane without twists and without accumulation.

The original unit was designed and built in 1931 and in 1932 was installed at the Waukegan Works of American Steel & Wire. Used for reducing No. 5 low carbon rod (0.220 in. diam) to No. 13, 14, or 15 wire, the machine speed range was from 800 to 1000 fpm. Each of the five blocks was driven by a 10/15-hp, 1700/2300-rpm., shunt-wound, d-c motor with 230-volt d-c shop supply used as the machine power source.

Worm gears and wheels were used for speed reduction between the drive motor and block with the worm gear made integral with the motor shafts, Figure 4. This arrangement permitted the use of horizontally mounted motors.

At the drawing speeds for which this machine was designed, auxiliary cooling was required for the first time of both die and wire on the block. The source of the cooling air was a fan integrally mounted on the individual block motors. While this arrangement was relatively simple, it only satisfied a narrow range of machine operating speed, a fact which is evident when analyzed from the basic consideration that the volume of air required is directly proportional to the wire speed, while the air delivered by a fan is proportional to the third power of the speed. The integral fan and motor cooling design was replaced by separate motor-driven blower systems on most of the machines built since 1936.

In 1934 the first unit was designed and built with a wide speed range. Each block was driven by a 10/15-hp 800/3000-rpm, shunt-wound d-c motor, and shop d-c supply was used as the power source. This design was mechanically the same as its predecessor except that an additional stage of planetary gearing had to be used to provide the drawing speed range of 144/540-fpm.

Three blocks of modified design were built in 1936 for a large Eastern company. The worm gears were carried on their own bearings and connected to the motor through a flexible coupling, Figure 5. A separately

Figure 2 — This single deck unit was introduced in 1923.

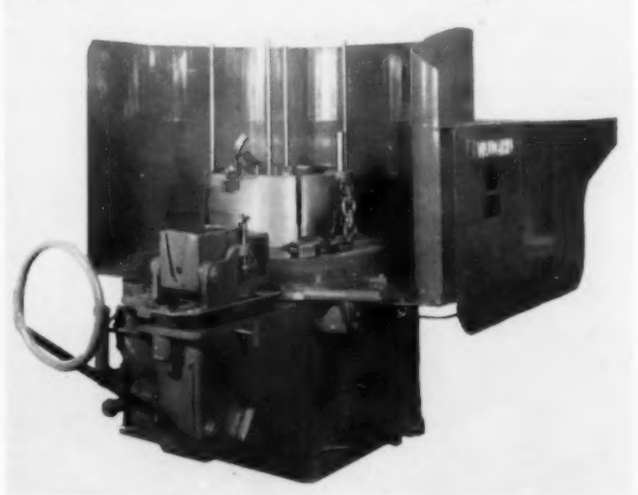
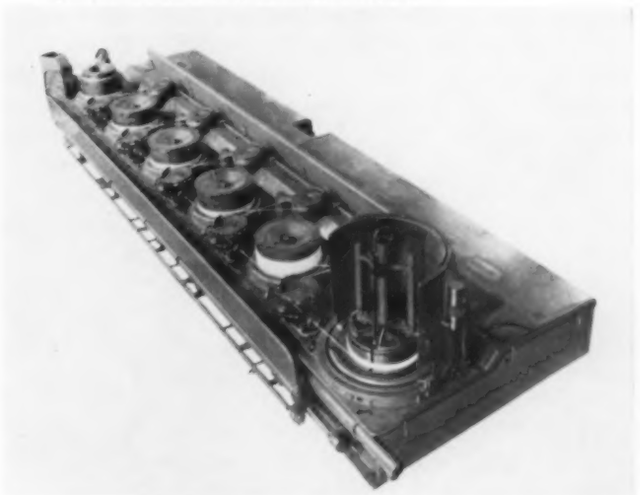


Figure 3 — This unit incorporates individual adjustable speed drive motors for each block.



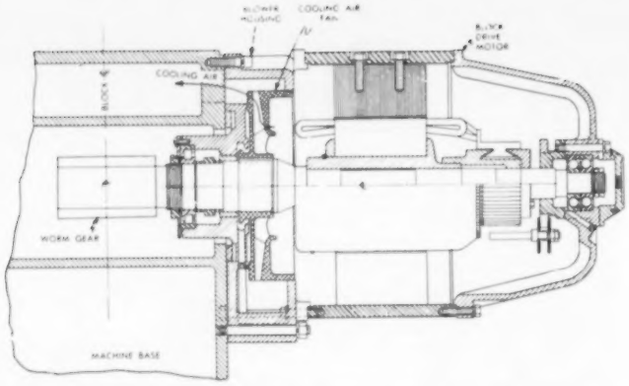


Figure 4 — This motor mounting and individual block drive assembly was first used in 1931.

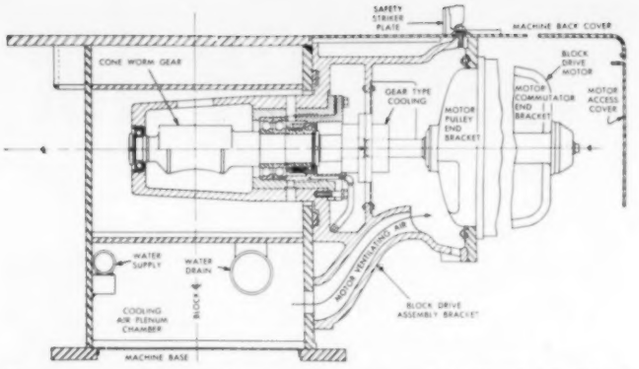


Figure 5 — This motor mounting and individual block drive assembly was first used in 1936.

driven fan supplied air for wire cooling, and water cooling of the dies and blocks was introduced. This group of machines was used for intermediate finishing — reducing No. 6 wire to No. 16 and finer.

In 1937 a block was built with increased motor rating of 15/22½ hp. Simultaneously the machine drawing speed was increased to 1000/1400 fpm. A separate motor-driven fan provided external cooling air for the wire, blocks, and internal water cooling of the blocks and dies was also provided.

For the next several years, drawing speeds were gradually increased by several design modifications and changes in operating practices. The machine speeds were approaching the point where it was necessary to start guarding the machines as a safety measure. A guard was placed along the entire front of the machine, Figure 6, which could be raised or lowered. When the machine was being strung up, the guard could be lowered and the machine could not go into "run" until the guard was raised.

A guard was also placed around the finishing block. This guard protected the operator, but also obstructed his vision of the bundle condition and size, so a counter was then added with a predetermined count contact in the machine stop circuit. A photo-electric eye was also added so that when the bundle built up near the top of the block or stripper pins, beam interruption would stop the machine.

As machine speeds moved upward, higher entry speeds presented a problem and better payoff arrangements with greater storage had to be provided. The snarl switches, which stop the machine in the event of a tangle in the bundle, had to be relocated. The original machines required only several feet of travel at the payoff, while the higher speeds required three to four times this amount.

With the higher speeds, increased cooling by both air and water was required. In 1951 the machines were redesigned to provide increased speed, incorporating larger water drains and larger cooling fans to deliver greater air volume at higher static pressures. The motor sizes were again increased—from 30 to 40 hp. To maintain the compact design, cone type worm gears and wheels as required replaced the conventional worm and planetary drives.

The machine was redesigned again in 1955 for a top speed of 4000 fpm, although this high speed represented an operating potentiality considerably in excess of current operational practice. The air and water cooling systems were again increased in capacity to accommodate the higher speeds. The finish block was made of steel and was dynamically balanced to closer tolerances than had previously been required. All of the guide and dancer roll sheaves at the finish end of the machine required better balance than on prior machines, and motor size was increased from 40 to 55 hp for each block. With that step upward in machine speed, the electric drive system also was due for a complete review and redesign.

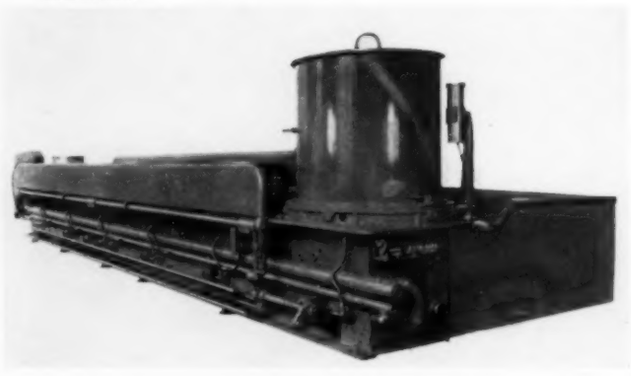
Up until that time, maximum machine speeds had been attained with a common generator adjustable voltage system. System stability had been made possible by first keeping the dancer roll sensitivity (fpm change per inch of storage) within certain limits, and by maintaining a high degree of inherent motor speed regulation. Staying within sensitivity limits at higher wire speeds meant either increasing the physical storage between blocks or changing the electrical drive system. With the existing basic machine design this solution of increasing the physical storage between blocks presented a problem in that it meant doubling the sheaves on the dancer arm and an additional idler.

The estimated cost relationship between mechanically providing increased storage, and an electrical system utilizing individual regulators and generators or boosters proved to be a standoff. The conclusion of this study was the selection of the regulated multiple generator system.

ELECTRICAL DESIGN CONSIDERATIONS

From an electrical standpoint there have been three

Figure 6 — Safety guard on the front can be raised or lowered.



types of drives applied to multiple head continuous machines that have utilized multiple drive motors prior to 1955. Each type represented an advancement in the art of wire drawing, but each type reached its inherent limitation as increased operating speeds were attained, Figure 7. It is significant to note that high speeds have been obtained only within the last 15 years.

The constant potential multiple motor drive was first used in 1932. In the ten years during which it was the accepted drive system, machine speeds were advanced from 350 fpm initial speed to 2000 fpm. Special consideration had to be given the control design to provide smooth starting; for example, dancer roll stability was obtained by heavy motor stabilizing (series) windings and to a limited degree by tailored dancer roll rheostat filling. Fast stopping with minimum dancer roll movement was accomplished by group dynamic braking and individual shorting of the series stabilizing windings of the d-c drive motors.

The constant potential system reached its speed limitation very rapidly as the machine speeds moved upward and the need developed for machines that would operate with a minimum of dancer roll movement over a wide range of motor loading. A large percentage of the units, through which wire is being drawn today on multiple motor machines, are of the constant potential type. Machines are still being built today powered from constant potential plant supplies, but these machines are, in general, used only for limited product ranges at lower than what might be termed permissible speeds today.

As the machine speeds moved upward, there was a need for a wider operating speed range and a lower string-up speed relative to the rated operating speed. This requirement, coupled with the limiting of the motor field range to reduce the dancer roll sensitivity at higher speeds, resulted in the introduction of adjustable voltage being applied to limited field range motors (rather than constant potential shop supply and wide field range motors).

The introduction of the variable voltage system in 1941 allowed machine speeds to move upward comfortably once more. The motor characteristics used to gain limited dancer arm movement still were dependent on motor loading. Various attempts were made to divorce product range from machine stability, and, while these attempts were successful to a degree, none proved to be the universal answer. In general, the added first cost of regulators could not be justified by the operating departments.

In 1953 an installation was made at the Steel Company of Canada, utilizing individual booster generators for all block motors. The motor fields were manually trimmed to position to mid-operating range the dancer rolls, which, in turn controlled booster generator fields. This system afforded two distinct advantages: (1) stable machine operation with speed increased from 2500 to 3300 fpm, and (2) motor loading divorced from machine stability.

While these advantages were considered significant

Figure 7 — Graph shows increase in machine speeds over the years.

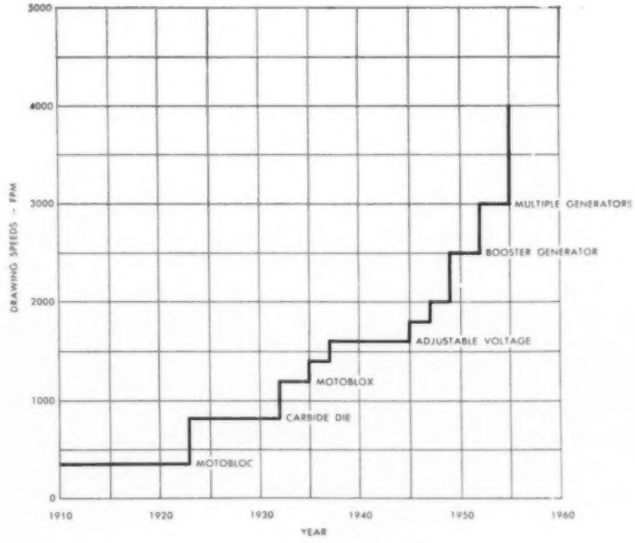


Figure 8 — Self-contained assembly eliminates need for separate control and power room.

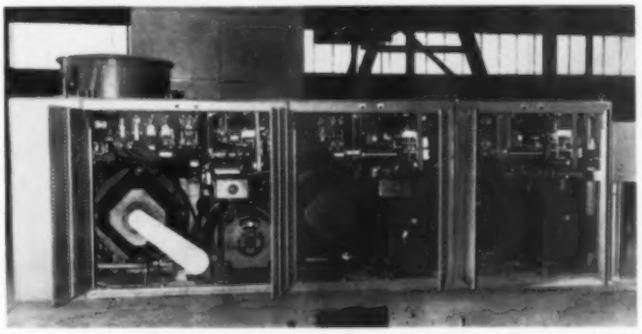


Figure 9 — The assembly's completely self-contained power and control unit is shown with doors open.

Figure 10 — The follower block section module contains all the equipment for the specific drive motor contained therein.

and a definite improvement operationally, the increase in electrical equipment first costs could not be justified on additional machines under consideration at a later date.

From the operation of the booster arrangement, it was concluded that if higher speeds were to be obtained and the flexibility of the drive system extended a system embracing individual voltage control offered the greatest promise. When costs were reviewed, it became evident that the first costs would be greater whether individual generators or booster generators were used, compared to the variable voltage system utilizing a common generator.

Simultaneously with the system analysis being made, a study of the over-all capitalization of new machines was also made. It pointed out that the cost of installation of common generator variable voltage systems was sometimes as high as the first cost of the complete electrical drive system alone. This fact offered another approach to the over-all problem: if some means of reducing the over-all installation costs could be found the saving could be invested in an improved drive system.

Two accepted means of reducing the overall electrical

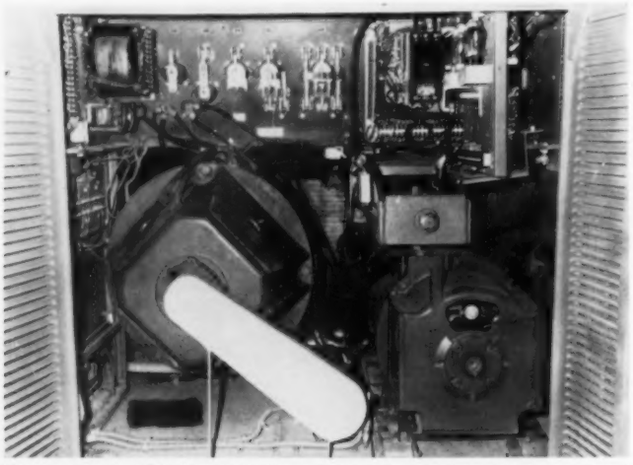


Figure 11 — Finish block section module of power and control unit.

Figure 12 — Setup devices are located in the door to this section.

Figure 13 — Variable speed power and control units are remotely located in a separate power room.

installation costs have been in general practice in industry: (1) "built-in" control, regulators, and conversion equipment, and (2) separate packaged control, regulators, and conversion equipment.

In the final analysis, the built-in arrangement offered further advantage in that by spreading the normal machine foundation centers a few inches and increasing the overall machine height a few inches, the built-in control, regulators, and conversion equipment could be completely contained in one assembly, eliminating the need for a motor generator and control room or basement, Figures 8 and 9. For new plants the elimination of the control room or basement offers an even greater economy.

In the final design, each element of the machine drive is sectionalized into the following groupings:

1. Tandem control which includes common function devices, constant potential exciter for motor fields and control, and machine setup devices.
2. Finish block motor, conversion unit, and control.
3. Follow block motor, conversion unit, and control.

The follower block section module, Figure 10, contains all of the equipment for the specific drive motor contained therein. The power unit, a high-speed design with two-bearing construction, is resiliently mounted on a six-roller base, and is provided with long leads so that it can be easily removed for inspection and maintenance without disconnection. With the power unit removed, easy access is afforded to the motor, coupling, and dancer roll rheostat. The close proximity of motor, power unit, regulator, and control to the machine allows maintenance personnel to observe machine operation, eliminating the necessity for two men and an intercom system to analyze and setup drive operation. Figure 11 shows the finish block section module. All features outlined for the follower block section are maintained throughout. Figure 12 shows the tandem group. The setup devices are located in the door to this section.

The separate packages of conversion equipment, regulators, and control require the equivalent amount of area as the common generator arrangement. However, the packages are enclosed and filter-ventilated, and thereby do not have to be located in a control room only. Figure 13 shows a typical variable speed packaged installation where the power and control units are located remotely in a separate power room. The same sectionalization of the machine drive groupings are maintained. The tandem control group and finish block grouping are packaged in one cabinet; each follower block group is packaged in an individual cabinet.

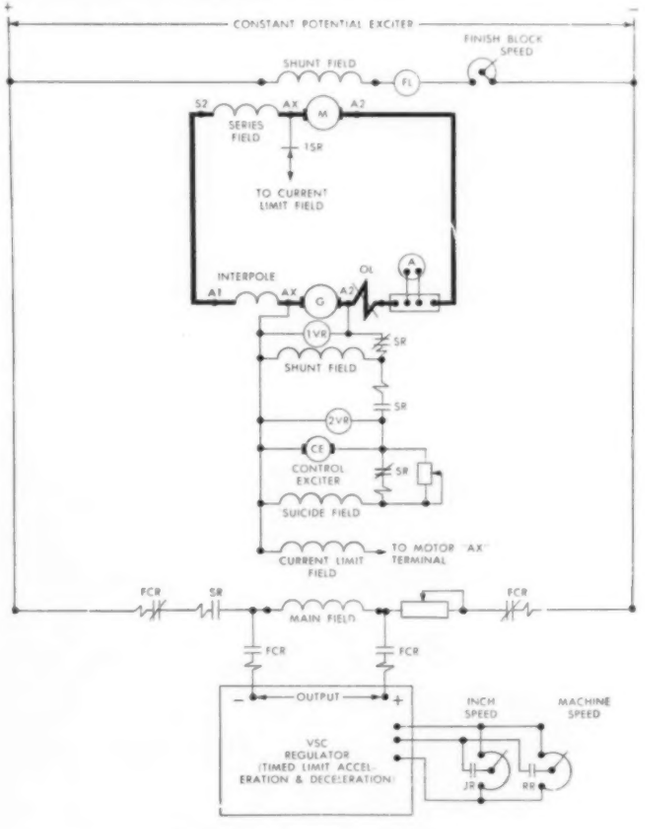
The "built-in" packaged machine offers further mechanical design improvement. The motor side of the machine has been covered over its entire length by sheet steel panels which, although removable, have not afforded easy access for normal inspection. The built-in construction offers easy visual checking by merely opening the hinged doors. The striker plate on the back side of the machine is made integral with the cabinet and provides more complete protection. The dancer roll tension springs are in a position where they can be adjusted with the machine running. The design modifications required for providing the built-in construction were required in the machine base and cover, thus plants with a quantity of machines of earlier design have complete interchangeability of moving parts.

The ventilating system is the same as that for machines of earlier design, with motor ventilating air bled from the machine base plenum chamber. Two-bearing power units are provided with an integral fan that draws air from a trench at the base of the machine or air tunnel in the floor. The machines of this design are easily moved, allowing greater flexibility in plant layout. The close proximity of the machines to a given plant area is no longer required.

SYSTEM STUDY

An analog computer study was made to determine what system offered the best drive. Four systems were reviewed and the system described indicated the best overall characteristics when viewed from transient response, system stability and response to step function error introduced.

Figure 14 — Schematic shows fail-safe contactorless control system for finish block.



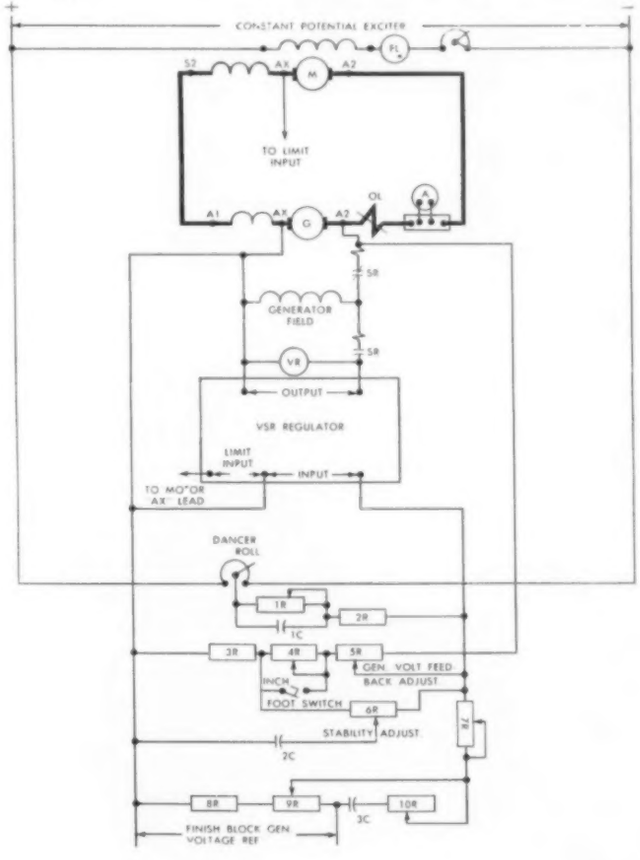
The system utilizes the same operational functions as used on previous machines; the finish block is the lead or reference unit with all other blocks termed follower blocks. The finish block is basically a fail-safe, contactorless system, Figure 14. At rest or stop, suicide relay SR is deenergized.

Pressing the inch rail will cause SR, JR, and FCR to be energized, thus connecting the generator shunt field across the control exciter, disconnecting the control exciter suicide field, and causing the VSC to supply excitation to the main generator through the control exciter. Excitation is applied in a linear (time vs. voltage) relationship, assuring a smooth start from rest. A generator voltage feedback loop is employed in the VSC to maintain a repetitive stable inch speed regardless of motor loading.

Pulling the run rail causes the VSC reference to be transferred from the inch speed reference changes the generator voltage under time limit to the valve for preset speed.

Pushing the run rail to the stop position; the tripping of a snarl switch, broken wire switch, or full bundle switch; or operation of a circuit protective switch causes the machine to stop first by deenergizing FCR. Opening FCR transfers the control exciter main field from the VSC regulator output to the exciter bus in the reverse direction. This drives the control exciter toward the reverse polarity. Current limit action is provided by the generator interpole, plus motor stabilizing field voltage drop exceeding the spill-over voltage of the current limit rectifier 1SR. This spill-over action forces the control exciter to maintain a rate of change which will not allow the armature current to exceed a safe

Figure 15 — Schematic shows follower block control system.



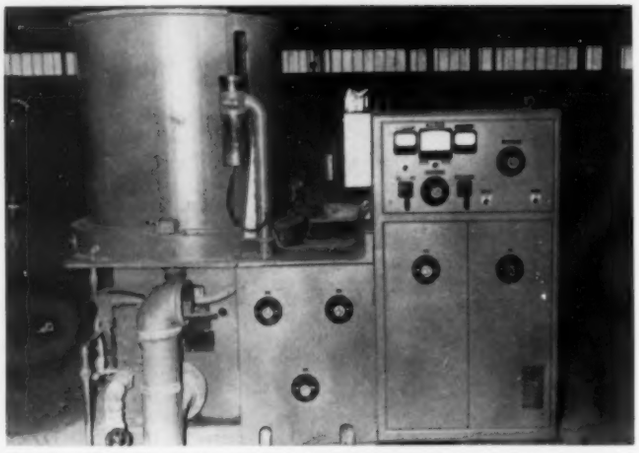


Figure 16 — Operator's position for machine setup permits simultaneous checking of dancer roll positions and control of all drive motors with control rheostats.

value. When the generator loop voltage drops below the drop-out point of 1VR full generator field suicide is applied by deenergizing SR.

All follower blocks are identical, Figure 15. The basic reference signal is taken from the finish block generator voltage applied across resistors 8R and 9R. Resistor 10R and condenser 3C provide a rate of change forcing signal to the follower regulator. Basic feedback voltage is taken from the follower section generator and appears across resistors 3R, 4R, and 5R. These two signals provide the basic operating point of the follower section, and the dancer roll rheostat then provides a vernier reference modification to control the section voltage and maintain dancer roll position. Resistor 1R and condenser 1C provide a rate of change forcing signal. These signals are compared to the regulator in a parallel input circuit.

The voltage feedback signal is modified by the foot switch to provide a higher speed on the block being strung up. This is a necessary operating feature, to cause the dancer rolls on the blocks immediately ahead of the block being strung up to remove all slack and some into operating range more rapidly.

The generator field is connected across the section generator when the machine is stopped. Pressing the inch rail will cause the follower blocks SR suicide relays to pick up simultaneously with the finish block SR relay. This will cause the generator field to be connected to the section regulator. The finish block generator voltage will then establish the reference for the follower regulator which is further modified by the dancer roll position.

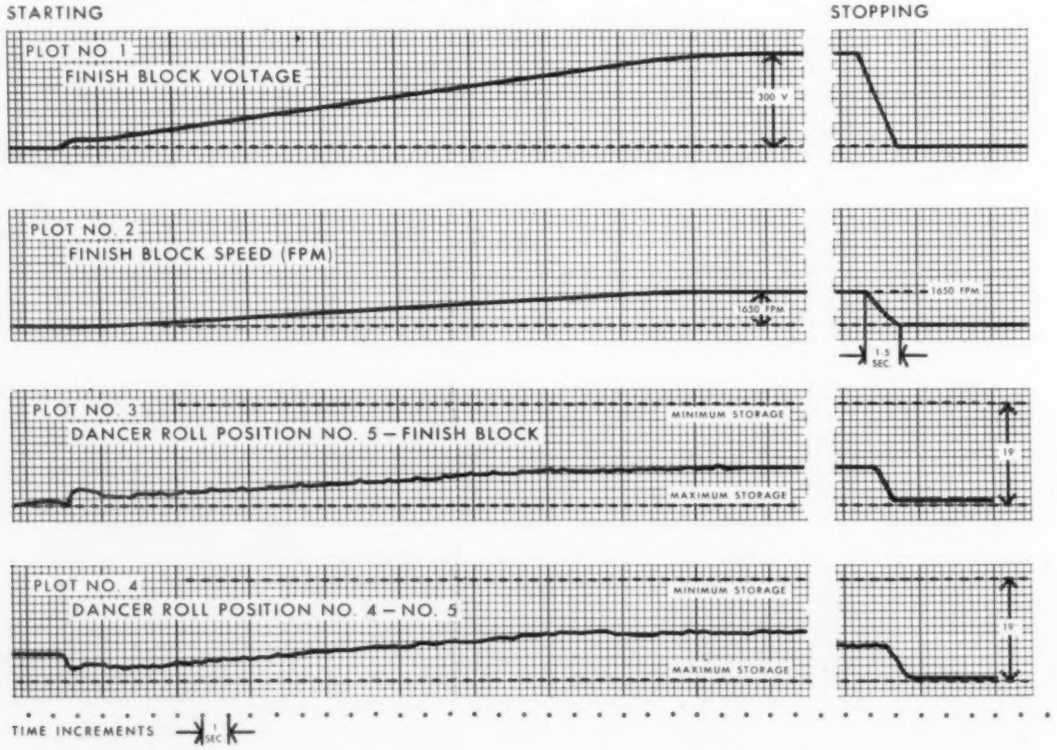
Pushing the run rail to the "stop" position will cause the finish block to stop as described previously. The follower blocks will regulate to the finish block voltage and be modified by dancer roll position to a low voltage at which time 1VR drops out in the finish block control which simultaneously deenergizes all of the suicide follower SR relays. This will apply full generator field suiciding simultaneously at a low operating speed. Current limit is provided on each follower section, provided as a protective rather than an operational feature.

MACHINE SET-UP PROCEDURE

For setting the machine up, Figure 16, all of the motor field rheostats are panel mounted in a convenient position where the operator can simultaneously check the position of all dancer rolls and control the drive motors.

The set-up procedure is to string the machine up, disregarding the setting of motor field rheostats from the previous drafting and final operating speed. The dancer rheostats have sufficient voltage range so that extreme settings of motor fields will not move the dancer rolls out of range. After strung up, the operator can reposition the dancer rolls to the desired operating

Figure 17 — Graph shows rate machine performs with operation set at 1650 fpm.



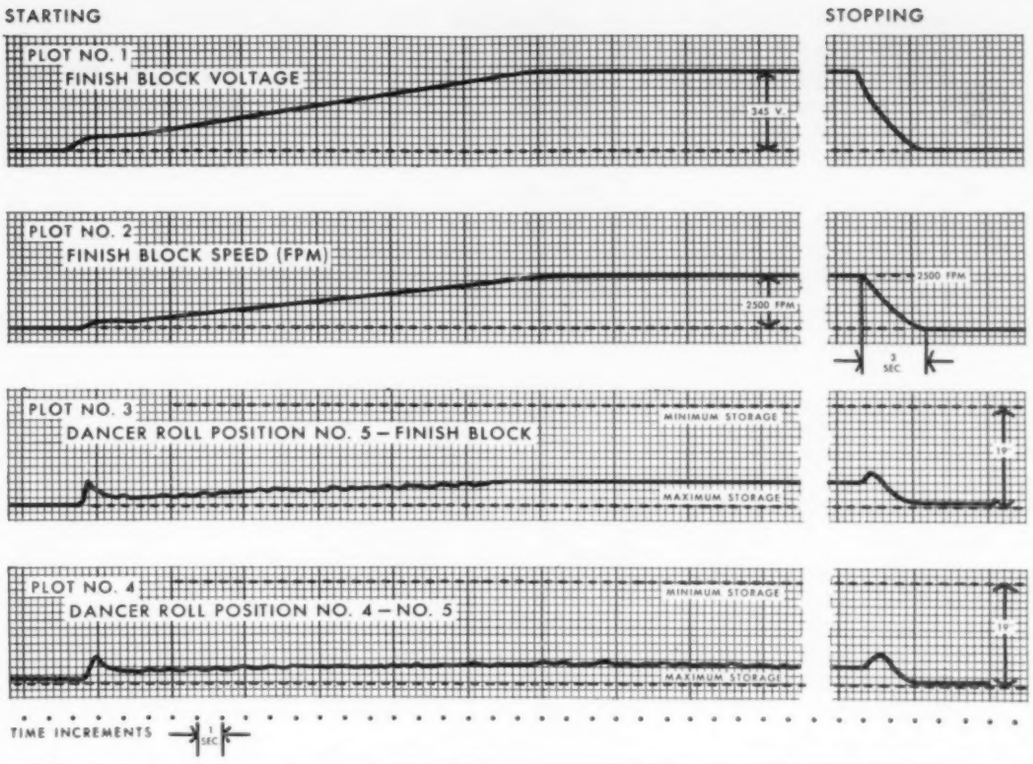


Figure 18 — Graph shows rate machine performs with operation set at 2500 fpm.

position. Then the machine may be brought up to preset operating speed by operating the run rail. Moving the run rail to the "run" position will cause the machine to accelerate under time limit control. From the set-up position, individual block loading and performance can be monitored, and "machine stop" pushbutton is provided.

At first it was felt that requiring the operator or setup man to set the motor fields manually would be a handicap. Because it is a function that can be performed after the machine has been strung up, and the actual procedure is just observation of a machine element from a convenient location, it is not the burden originally anticipated. The motor field setting of each block is a function of finish block speed and the specific cross-section area of the section's die. Therefore, it is possible to establish the rheostat settings ahead of time from the drafting scheduled for the machine. Either method of field rheostat setting is easily established by personnel without an electrical background.

PERFORMANCE RECORDS

Recording oscillographs were taken to show actual performance of a rod machine at Steel Company of

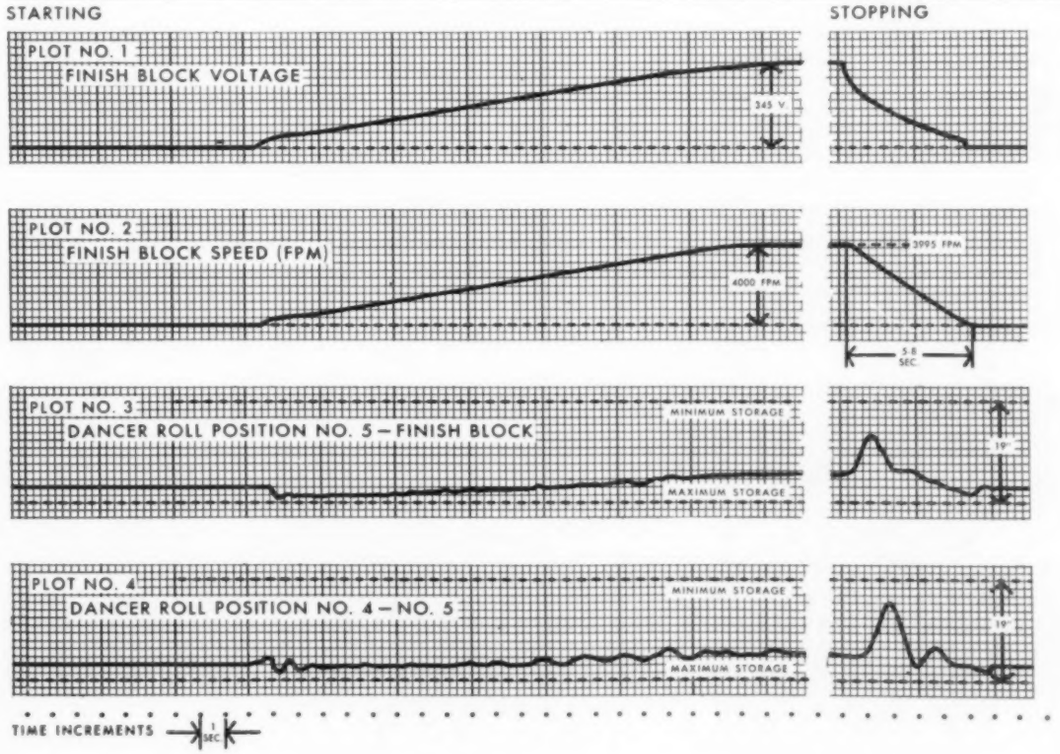


Figure 19 — Graph shows rate machine performs with operation set at 4000 fpm.

Canada, Figures 17, 18 and 19. The machine was drawing haybailing wire starting from 0.218 in. diam and finishing at 0.076 in. diam. The loading observed at maximum speed represented full load on the drive motors. The plots represent ⅔ load at 2500 fpm and ½ load at 1650 fpm. Drafting per die varied from 25 to 40 per cent, with an average of 29 per cent.

On all charts, Plot No. 1 shows finish block voltage, Plot No. 2 shows finish block speed, Plot No. 3 shows dancer roll position between the finish block and the No. 5 block, and Plot No. 4 shows dancer roll position between the No. 5 block and No. 4 block. The incremental line at the bottom represents elapsed time in seconds. Time starts with zero at the left and moves toward the right. It was at the operator's request that accelerating time be set at 21 sec. This is adjustable down to three seconds if desired.

Stopping time is a function of the current limit value established for the finish block. This value was set at 5.7 seconds from 4000 fpm. A shorter deceleration time causes shifting of the bundle on the finish block, resulting in loose loops of wire protruding from the bundle. Thus the stopping time is a compromise setting between safety and quality.

The charts show that dancer roll stability is independent of motor loading. The initial dancer roll movement is caused by the dancer rolls positioning themselves at start, because they will drift from position at the final suicide stop. The degree of drift is dependent on the die load and frictional variables.

The block motors start very smoothly from rest. On the common generator drives it was necessary to accelerate as fast as possible to the string-up speed, because the motor field control of the dancer rolls is relatively ineffective at voltages below this point. With higher speeds, while maintaining the same amount of wire storage in the dancer movement, a greater dancer roll sensitivity (fpm per inch of storage) is the result. Thus any excessively high rate of acceleration with varying degrees of die load would cause wire breakage. The smooth start practically eliminates wire breakage.

In setting the drive up initially, the stability and forcing signals to the follower block regulators were set to favor dancer roll movement toward the maximum storage position on stopping. The operating people found this to be an advantage in that a variable drafting set up could be used beyond the normal plus or minus 5 per cent. This was possible because the dancer rolls can be operated without the danger of wire breakage as close to the mechanical stops as necessary to obtain proper operation.

SUMMARY

The most recent design described both mechanically and electrically is capable of top speeds in excess of 4000 fpm. At the present, this speed is ahead of the progress that has been made for providing suitable dies and drawing lubricants for such finishing speeds. Coincident with the development of increased speed has come a demand for large finished wire bundles. The larger the finished bundle, the less often the machine has to be stopped for stripping. The machine of the 1930's ranged from 150 to 300 lb. Today many bundles range from 1000 to 2000 lb with occasional demand for 3000 to 4000 lb. All of these factors indicate that the rate of rise shown in the curve of Figure 7 will continue. The forward thinking of the mill engineering and operating departments coupled with the desire to design and build machines to produce more wire per man per capital dollar invested has advanced the art of wire drawing to its present state and will continue to spur the advance.

DISCUSSION

PRESENTED BY

D. C. McCRADY, Chief Engineer, The Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

WILLIAM E. ZELLEY, Chief Project Engineer-Electrical, John A. Roebling's Sons Corp., Trenton, N. J.

ROSS D. SPALDING, Engineer, General Electric Co., Schenectady, N. Y.

ROBERT C. SUTTLE, Application Engineer, Reliance Electrical & Engineering Co., Cleveland, Ohio.

D. C. McCrady: The authors of this paper have given an excellent summary of the evolution of multiple block wire drawing machines. To some, it might seem a little odd that the final somewhat revolutionary machine design should find its first application in Canada, and for this reason an explanation of the background might be in order.

About five years ago, we had become quite interested in finding a means to adjust our variable voltage frames for more flexibility. Drawing schedules in our Canadian mills had to be flexible due to the variety of wire sizes and grades made on a relatively small number of machines; we were of course interested in speed, which could only be achieved by careful electrical adjustments, such as dancer rheostat stacking, dynamic braking and field forcing settings, and series field adjustments, for any one group of schedules. As soon as we attempted a different schedule, the machine became unstable, and stopping was a problem. About this time, too, considerable publicity was observed concerning back-pull wire drawing in England, where dancer rheostats were eliminated, and the block motors were connected in series; this scheme had, we felt, some disadvantages which ruled out this style of machine for our particular purposes at the time. We knew that the limit had been reached on motor field control, and we turned our attention to what might be achieved with voltage control.

We approached the manufacturers concerning the problem, and finally a design was worked out to add a booster generator set to one of our new variable voltage machines which was on order. In addition we had not been too enamoured of the step type acceleration controls and the extremely non-linear speed time characteristics of the conventional generator field decay system and dynamic braking, which we thought was the cause of at least some wire breakage. The new equipment was built to give us several methods of improving control namely:

1. A rate of change voltage control on the generator,

eliminating dynamic braking and time contactor starting.

2. Booster generators arranged with one field operated by the dancer rheostat, the other for IR drop compensation.

3. Motors have the conventional heavy series field and full shunt field as well. The machine could thus be operated normally; but by cutting out the series fields and using booster control, the motors were then operated strictly by variable voltage with the shunt field strength adjustable by the operator.

4. We also could lock the dancer arms, and set the machine up for back pull wire drawing by properly setting the shunt field rheostats.

A great deal of experimental work was carried out on this machine. Back pull drawing was not successful, with the large inertia of the finish or storage block being difficult to compensate in the control. It thus appeared that the dancer rheostats were really an advantage, considering the variable inertia of the finish block with the larger bundles being used today. Moreover, inertia compensation was difficult to achieve at the speeds of around 2500 fpm, considering that we had more than two to one range by field control on each block motor, despite the fact that acceleration and deceleration was fairly uniform with the new generator field control.

Results on this machine indicated some definite advantages however:

1. The entire speed range of the block motors could be utilized, allowing speeds up to 3000 fpm on low carbon wire (actually the horsepower on this machine was insufficient to draw high carbon wire at the high speeds). This result was achieved due to the fact that on conventional control, a large part of the motor field range had to be used for dancer arm control whereas now the dancer arm rheostats utilized booster voltage as its means of adjustment.

2. Drafting, and therefore loading, on the different blocks could be widely varied with perfect control being achieved regardless of motor loading, as for instance 15 per cent draft on one block and 35 per cent on the next. Stopping under variable conditions as well as stable operation with no adjustments being necessary, were completely successful.

3. Uniform stopping and stable operation resulted in fewer wire breaks.

Successful as this machine was, we knew that it was not the final answer. Booster generators were expensive. Further, more voltage range on the dancers would be preferable, since we had only about 30 volts full range, the remainder of the rated booster voltage being taken up by IR drop compensation. Thus we began to look towards the individual generator scheme. When the manufacturers indicated that they thought a machine could be built with the motor generator sets mounted in the frame itself, we believed this was the answer. The characteristics which we wanted were worked out, finally resulting in the machines described. A great deal of attention was paid to access to the control, ease of removing motor-generator sets, and so on. We placed an order for five of these machines, which went into operation early this year. These were even more successful than the booster controlled machine. Still wider drafting could be and is being used. String-up was simpler than we had expected, since the dancer arm voltage range, being fixed, represents a large proportion of the total voltage at string-up speeds. Thus the operator could easily string up a new schedule, and then adjust the motor field rheostats to bring all arms to the same position, after which the machine could be brought up to speed with no further adjustment.

At the moment, our limit on speed is a function of the snarl switch design. We have had successful stable operation at 4000 fpm, but stopping is a problem as far as length of ingoing rod is concerned. Even with a $2\frac{3}{4}$ second controlled stop from 3000 fpm, the snarl switch does not have quite enough storage. These switches are being redesigned for more storage at the present time. At the moment, cooling of the blocks and dies appears adequate. However the next problem facing higher speed operation will undoubtedly be a matter for lubricant design in order to obtain the required physicals at these higher speeds. These problems have been faced and solved on cold rolling of steel strip, and undoubtedly they will be solved on wire machines. At least we feel the speed and flexibility bottleneck has been solved for the moment as far as electrical design is concerned.

As to economics, the machine built with individual motor-generator sets is more expensive than a conventional machine, but since there is no motor room or other costly installation involved, the over-all expense is about the same. Moreover it is far easier to shoot trouble with all the controls at the machine itself. Wire drawing machines, it would seem, have now reached the status of special purpose factory assembled machine tools.

William E. Zelley: For many years one of the most serious problems facing those who were concerned with either the design or operation of multiple motored continuous machines, has been that of obtaining stability of the dancer rheostat operating arms particularly during acceleration and deceleration of the motors.

The control described by Messrs. Nye and Suttle seems to have the ability to accomplish the desired result, a stable machine at all speeds and at all times.

It is interesting to note that the new control method uses a dancer operated control to regulate the motor speed within a desired range, the primary or basic speed setting being made by the operator's adjustment of the speed controls located at the delivery end of the machine.

This principle calls back memories of the late 1930's when it was the usual practice for these machines to be equipped with two rheostats for each motor, one of which was located on a control panel and connected in series with the dancer operated rheostat located on the machine. Since the machine dancer operated rheostat had only a relatively small portion of the total shunt field regulating resistance, its function was only to regulate the motor speed to a value slightly above that determined by the preset rheostat on the operator's panel.

This resulted in a large movement of the dancer rheostat for a small change in the motor speed and was found to work in a very satisfactory manner except that the operator was required to adjust control panel rheostats for every major speed change or die arrangement.

As speeds were increased and more experience was accumulated by the motor and control manufacturers, the machine builders and operating personnel, the two rheostats were combined into a single dancer operated rheostat which was capable of covering the full speed range of the motor.

This improvement reduced the operator attention required, but as speeds were increased the problem of maintaining stability over the entire range of speed and load again became an important consideration.

The designers of this new control are to be commended for their ability to recognize this important operation of several years ago, and by using really modern equipment obtain a smooth operating, stable machine assembly that places within the reach of the wire drawing industry the possibility of greatly increased operating speeds.

Ross D. Spalding: Let us look at the old machine versus the new machine with reference to the use of the dancer arm controls, since the dancer is the heart of such a machine.

There were six functions required of the dancer on the old machine. First, the dancer was asked to track the final block through a fairly wide speed range. This meant that extra motor field range was necessary for regulating ability above and beyond that required to track the master or final block.

Secondly, the dancer had to have additional range to take care of a flexible drafting schedule. As increased reduction was taken per die, this meant that all capstan speeds had to decrease for a constant speed of the final capstan. The reverse was true for a decrease in drafting schedule.

At this point it is well to note that these first two requirements took up practically 90 per cent of the dancer's regulating range. These functions contributed largely to the gain of the dancer regulator. (Gain being defined as the feet per second change in wire speed per foot change in storage.)

Third, regulating range had to be provided so that the dancer could take care of transients that would be encountered. Acceleration and deceleration, hard spots in the wire, etc., would be examples of such transients.

Fourth, the dancer still had to have sufficient range to accommodate die wear.

Fifth, IR drop in the armature circuits of the individual motors had to be considered since unequal loading would be the rule rather than the exception.

Lastly, the individual motor fields probably would heat to different ultimate temperatures at different rates and would cause the motor shunt field excitation to change for a given position of the dancer rheostat. This also would cause a speed change which had to be coordinated between capstans by the dancer.

Since increasing the line speed of the old machine would cause the position regulators (dancer controls) to become unstable because of the increase in gain, it follows quite naturally that some method had to be devised to reduce the regulating range, and therefore the gain of the dancers, if higher drawing speeds were to be obtained. This is just what has been done on the new machine. It includes individual motor shunt field rheostats which can be preset for both draft and top speed. From my previous statement, draft and speed range accounted for almost 90 per cent of the dancer's regulating ability. As a net result, the manufacturer has automatically lowered the gain of the position regulators and achieved stability at much higher drawing speeds. Here is the key to the successful operation of this new machine.

We still have the dancer accounting for such things as die wear, motor field heating, IR drop, and transients. However, all of these, with the exception of transients, are slow change disturbances which can be corrected by the operator by just watching the dancers and keeping them in the center of travel.

The reason I am in complete agreement that this is the right way to approach this problem, is because our company has used this same technique for some time on high speed wire flattening mills. Specifically, this means using individual field rheostats and letting the position regulators act only in a vernier capacity.

But now we might ask why we should use the dancer working on the generator field instead of the motor field. In both cases, looking at it from a regulating standpoint, you would have a shunt field time constant and a motor inertia time constant to contend with. The answer to this problem rests with two important facts. First, the individual motor-generator sets can be made high speed which would mean physically smaller generators for a given kw rating. This means in general that you could expect a lower time constant from the generator shunt field as opposed to the motor shunt field. Secondly, by changing the generator shunt field excitation as a function of the dancer movement, you would not affect the regulating system gain. This would not be true if the dancer causes changes in the motor shunt field excitation, because you then would not only change the gain of your position regulator, you would also change the motor shunt field time constant.

Therefore, it appears entirely correct to use dancer control through the generator shunt field rather than through the motor shunt field. However, even though such a decision can be justified, it will probably be necessary to use a regulator of some sort, as was done here, to reduce the effect of the shunt field time constant. The reason for this is because a position (integrating) type of regulator can not tolerate anymore than one time constant of any significance. In this case, that would be the motor inertia time constant.

In looking through their paper, I am a bit curious as to why the control exciter was considered necessary on the final or master block control. This introduces another time constant to the system which could be considered detrimental. With this type of arrangement, the master signal goes through the electronic regulator, through the control exciter, through the finishing block generator, and *then* to the preceding voltage regulators as a common voltage reference. As opposed to this type of circuit, why not use a common voltage reference to all blocks, including the finishing block. This would eliminate the use of the control exciter.

Secondly, I notice from the circuits shown that the generators are suicided while the machine is at a stop. I would think, with voltage regulators present on each and every one of the block drives, that armature voltage preconditioning (regulate to zero voltage) would completely eliminate any possibility of generator voltage drift. This means that there virtually would be no

possibility of the blocks creeping while the machine was stopped.

Third, I wish to validate the fact that no string-up relays would be required if the ultimate user did not draw wire in excess of geared draft.

Fourth, if the individual field rheostats are not preset correctly in accordance to the drafting schedule, such that the dancer's would be out of range, how can the operator find time to readjust the manual rheostats without a "Hold" function? (The "Hold" function being defined as that which would interrupt acceleration until the run bar was reactuated.) Without such a function, I would assume one of two things must be done—increase acceleration time to allow the operator to readjust while coming up to speed, or have the rheostats correctly preset.

Robert C. Suttle: The control exciter on the finish block is used so that a single, controlled, rapid, and fail safe stop can be obtained with a minimum of equipment. The wire industry over the years have established the practice of utilizing such a stop on all wire drawing equipment. This stop has to be rapid enough so that a snarl occurring in the payoff bundle tripping a limit switch will not go through the starting die.

The analog studies of the electromechanical system revealed that at the higher speed and handling extremely large bundles, the finish block would require at least an average decelerating torque of approximately 250 per cent of full load. To obtain this would require a forced current limit stop. The study also revealed that the peak currents that would be required to produce this average decelerating torque utilizing conventional dynamic braking or generator field suiciding would be beyond the safe mechanical and commutation limits of the motor and generator.

With this as a background the control and regulating system applied to the finish block should have the following considerations incorporated in the design: (1) a single stop, (2) current limit control, (3) fail safe, (4) smooth and lineal, and (5) minimum of equipment.

In selecting the system ultimately used it was concluded that the multifield control exciter offered the simpliest and most reliable means of satisfying all the above considerations.

Since current limit stopping is an absolute necessity on the finish block, the use of a common reference for the finish block as well as follow blocks cannot be utilized in that once the finish block goes into current limit, the common reference would not be followed by the finish block while the followers would follow this basic reference. The dancer rolls then would have to make up this deviation. This deviation from the common reference would change with the bundle sizes. Utilizing the finish block voltage as the common reference for the follower blocks overcomes this problem.

The addition of the control exciter does not introduce a time constant to the position regulators. This time constant which is 0.166 sec is introduced in the system applied to the finish block only. The followers then take their basic reference from the finish block voltage which is smooth stepless and is as close an indication of speed as can be obtained. This also divorces this time constant from the follower position regulators.

The selection of generator field suiciding as opposed to regulating to zero generator voltage while at rest has several considerations. They are as follows:

1. Regulating zero voltage is one of the most difficult regulating jobs that presents itself. For one given time, and a given set of ambient and line voltage conditions, the system can be set up to regulate zero within the limits of the regulator characteristics. However, a-c line voltage transients, stray wire induced voltages can upset this condition.

2. Regulating zero under the stop condition would defeat the original design consideration of one single and fail safe stop. Any regulator whether transistor, magnetic amplifier or electronic is subject to rectifier, resistor, winding or element failure. Thus regulating zero generator voltage would require a second stopping function, and also a means of either generator suiciding, mechanical brake or a power disconnection of the armature power loop.

3. To regulate zero would require a means of obtaining negative ampere-turns on the generator to buck out the residual voltage. This would require either a bidirectional regulator output or a residual bucking held on the generator. Either substitution offers a more complete system than the system described.

It is true that the string-up foot switches would not be required if the actual drafting schedule were the same as the theoretical geared draft. This foot switch offers additional convenience because it allows the block to be strung up at a faster speed and also allows the wire to assume its normal position on the block and guide sheaves. This function has been left off on certain jobs and later added for operator's convenience.

The present method of operating the multiblock wire drawing machine has been evolved through the years. The "thread" or "inch" rail is a foot-operated bar activating a heavy duty mill master switch. This rail is spring-loaded so that it is a momentary function. It is momentary for safety reasons since it has to be operated with the front guard down. The "run" rail or front guard is a maintained function.

The addition of the "Hold" function would require either a third position of the run rail or another foot switch. The introduction of the foot switch would then mean that the operator would have three foot operating devices. Since a limited space is available, the foot switch seems impractical and possibly termed "unsafe." The third position of the "run rail" would be difficult to find in that the guard is somewhat cumbersome to selectively operate. Such a function could be added by a push button or selector switch at the operator's station. With these considerations it is felt that moving the rheostat at the operator's position offers the simpliest solution.

Operationally the operator is required to position the motor field rheostats after each die change. Under such circumstances, the introduction of "Hold" function instead of changing the speed setter position seems unnecessary. As was pointed out in the text of the paper, the machine can be strung up and operated up to about one third speed with the motor field rheostats out of range. String-up speed is between one-quarter and one-third speed. Under such circumstances, it is felt that the "Hold" function would not simplify the operation of the machine.

. . . . the future of the electric furnace will become unlimited as soon as it is divorced from a 100 per cent scrap charge . . . . possible alternates are use of hot metal, use of hydrogen-reduced ores, and desiliconized hot metal . . . . production of electric furnace pig iron at lower than present power rates provides another alternative . . . .

Economic Future of the Large Electric Arc Furnace

By W. B. WALLIS
President
Lectromelt Furnace Division
McGraw-Edison Co.
Pittsburgh, Pa.

▲ IN this discusson, we should first define what is meant by a large electric arc furnace. This is defined as a furnace having a minimum inside diameter of 22 ft, with a holding capacity of 125 tons, up to a furnace 30 ft diam, with a holding capacity of 250 tons.

We would suggest the substations back of these furnaces as 33,000 kva on the 22 ft, which would conservatively give this equipment a capacity to produce 200,000 net tons per year (25 net tons per hr) of good ingots on common quality steel and, on the 30-ft furnace, 60,000 kva, which would give this furnace a conservative capacity of 320,000 net tons per year (40 net tons per hr) of good ingots. It might be mentioned that operations are now being conducted on 20-ft diam shells with 25,000-kva substations averaging 23 net tons of good ingots per hr.

The question will at once be raised as to the load factor that might be expected from so large an equipment, but we feel that, if the electric furnace is to be a factor in the future in the production of steel, we have to stop thinking about 18 and 20-ft furnaces with substations from 20,000 to 25,000 kva. We have to think in terms of larger units—not just one or two of these larger units but a battery of, say six, with a connected load of 360,000 kva in the case of the 30-ft equipments.

Nicholson, in his paper published in the 1956 Proceedings AISE, has shown that the increase in installed electric furnace capacity has closely paralleled the increase in generating capacity in this country and, for the future, at the present rate of growth of the public utilities, loads of such a nature can be handled with the generating plants contemplated.

We are talking about the future and many steel companies, faced with gradual consideration of an installation of this size, would stop when they came to consider the matter of scrap supply involved.

The electric furnace, according to American Iron and Steel Institute tables, has in the past twenty years, risen from 1.7 per cent of the installed ingot capacity to 8.8 per cent. It has done better in the steel castings industry, having risen from 35.2 per cent in 1939 to 55.3 per cent in 1955. In the gray iron industry it is further down along the line, percentage-wise, than in the ingot industry.

It is interesting to note that, in a table published in the September 17, 1956 issue of *Steel* magazine, showing increases in ingot melting capacity planned by steel companies through: increasing size of open hearths, installing new open hearths, installing top-fired oxygen converters, installing electric furnaces, slightly over 14,000,000 ingot tons of capacity would be installed, of which, 2,280,000 tons were arc furnace capacity.

An interesting point is that, of the projected increase, 16 per cent of that increase is in electric furnaces or almost double the overall average rate of 8.8 per cent, shown by the Iron and Steel Institute tables. In other words, the rate of climb on the part of the electric furnace is accelerated.

Most steelmakers will agree that on 100 per cent scrap charges, with the power rates offered by the public utilities in this country, common quality steels can be produced for less money than with the open hearth. Mr. Lynch, of Atlantic Steel Co., has just published a very interesting article covering his company's experience and, in that article, makes the statement that their average cost of ingots is 5 per cent below the open hearths.

While this is definitely true for 100 per cent scrap-charged furnaces, the industry has not as yet come to the point where any completely integrated plant would

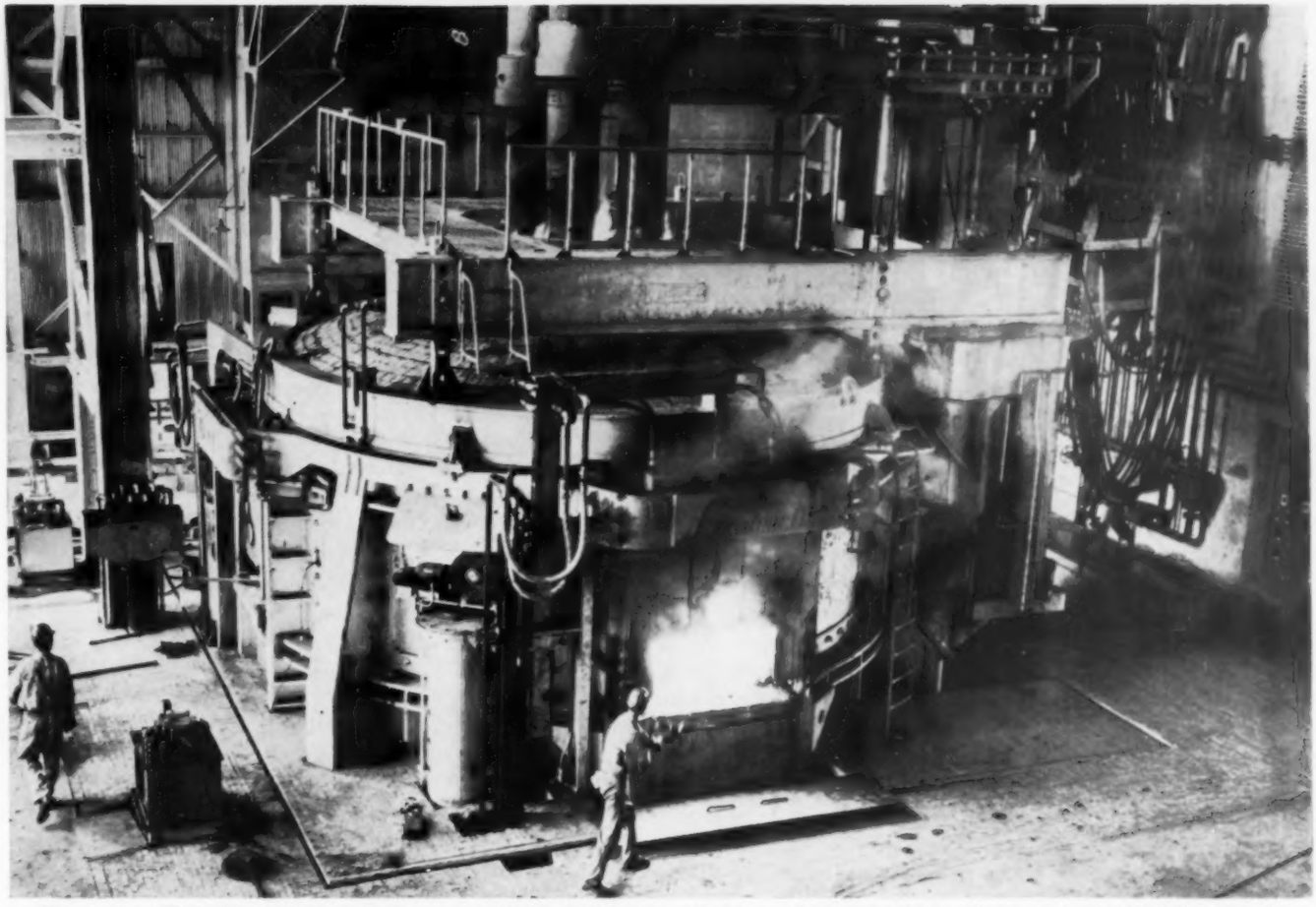


Figure 1 — This 24-ft electric furnace, recently put in operation in a large southern plant, is typical of the trend.

give serious consideration to replacement of their open hearth capacity with electric furnaces.

In a sense, it is surprising to note the continually increasing interest in large arc furnaces when one considers the economic picture at present and as we see it for the future. By this we mean, if we consider the electric furnace to be solely a 100 per cent scrap charge steelmaker, then it is, as we see it, heading for trouble. Scrap today is in short supply not only in this country but in every steelmaking country in the world.

In 1955, all of the steelmaking countries of Europe outstripped us in their percentage increase in electric furnace ingot capacity. In England the increase was 27 per cent, in France 22 per cent, in Italy 25 per cent, in Germany 35 per cent and in Belgium 90 per cent. Coupled with this fact is the increasing per capita use of steel in the world in general. A case in point is Australia, which, last year, reached 502 lb per capita as against 231 lb twenty years previously. This same story is being repeated elsewhere, all of which means that there is going to be a worldwide increasing demand for scrap.

While talk of 16 per cent increase in arc furnace ingot capacity in this country sounds big, it is really very small as compared to the over-all production of the steel industry. The open hearth is still the main producer of steel—ten to one over the arc furnace.

Not only is scrap in short supply but, due to the continual use of alloys in steelmaking, scrap today invariably contains a number of tramp alloys. Certainly, if the electric furnace is to take a larger bite out of the common quality open hearth production of this country, then the development of that increased tonnage is going to depend entirely upon materials making up the charge. The industry is ready to build 250-ton electrics. The electrode manufacturers have available the requisite 30 in. graphite electrodes for the operation of that furnace. The public utilities are in a position to take care of the load created.

The whole question of future development of the electric furnace depends upon the development of other charge materials than scrap that may be readily, efficiently and economically used in making steel in the arc furnace—preferably going directly to the ore for that material. That charge material must be of a cost that will enable the arc furnace operator to compete on common quality steels, not only cost-wise with the open hearth, but with the top-fired or horizontal-fired oxygen converter.

Sweden, of course, has been, for a number of years, working on the Viberg process for the production of sponge iron, although this has been limited to a project development of 30,000 tons per yr. We understand the cost of production is in the neighborhood of $55.00 per ton. It does produce a very fine grade of charge material and its cost could be justified in the production of higher grade steels, but we are here concerned with the production of common quality steels. Further, the plan has not envisioned any consideration beyond 100 tons per day whereas we have to talk in figures of producing charge materials in lots of 2000 tons per day.

Fortunately, the chemical engineers have been taking a look at this problem and, as a result of one investigation, a process for low temperature reduction of

iron ore by means of hydrogen has been operating in the pilot plant stage and studies are being made by one steel company as to the possibilities of building a 2000-ton per day plant. The pilot plant that has been running produces 7 tons per day and has processed about 1000 tons of Venezuelan ores and 1000 tons of Swedish ores.

The product of this operation is material running from 87 to 95 per cent Fe; phosphorous 0.039 to 0.048 per cent; sulphur 0.01 per cent to nil. In the process, carbon is reduced, sulphur is reduced, but phosphorous, silicon and manganese are not touched.

We have heard that a hydrogen reduction plant to produce 500 tons per day of this material would cost $8,000,000; a 1000-tons per day plant $12,000,000 and a 2000-tons per day plant $24,000,000. The cost above ore, not including carrying charges on the investment, would be $11.00 per ton for a 500-tons-a-day plant; $9.70 per ton for a 1000-tons-a-day plant and $8.00 per ton for a 2000-tons-a-day plant. With $22.00 cost of ore, this would certainly make a very attractive charge material, low in sulphur and not carrying tramp alloys.

The process is best suited to types of ore that are not high in silicon or in phosphorous. However, if we consider this as a charge material for the arc furnace, some of these objections might not hold as the operator could go to considerable expense in slagging to reduce phosphorous on the meltdown and could, within reason, take care of the silicon and manganese.

The material is mechanically passed through rolls and the resultant sheet about ¼ in. thick is broken up into pellets that average out in the charging box at 135 to 150 lb to the cu ft. Physically, the material is of a nature that it could not be used as a 100 per cent charge in an arc furnace but must be used with other materials. Some of the heats run indicate that slightly over 50 per cent of H-iron is about the maximum that the operator would like to include in his charge in making an electric furnace heat. This leaves us with 30 per cent of home scrap and 20 per cent of purchased scrap, if we consider the charge to be 100 per cent cold material.

The material, as a charge material, when properly treated, can be stored outside in open yards in heavy piles and transported over considerable distances.

The H-iron, as produced above under controlled atmosphere, is pyroforic until heated through to 1650 F, when it becomes stable. Two other companies have been working on slightly higher temperature hydrogen reduction of ores and in one instance, rather than rolling the reduced ore into a sheet and breaking it up, the plan is to charge the ore directly through the roof of the furnace into a molten bath, eliminating the rolling practice above described.

If the price of scrap is to remain at a level close to $60.00 per ton, then the engineers are bound to develop an alternate charge material direct from the ore that will be cheaper and much more desirable as a charge than scrap.

A second direction in which work has been done is that of Doctor Wright at the University of Alabama on desiliconized metal. His paper, 1956 Proceedings AISE, points out that, through the use of desiliconized metal, the capacity of any open hearth plant or electric furnace plant could be just about doubled.

Some objections have been raised on the point that it costs money to blow for desiliconizing metal and it costs money to transfer hot metal, but, as we see it, these factors are all relative. It boils down to what the cost of the charge material is in the furnace in relation to the tons of steel per hour produced and, certainly, desiliconized metal as a charge in the electric furnace would be ideal. It, however, envisages a blast furnace and the capital cost of blast furnace installations has risen to a point where such investments give pause to any but the larger steel companies.

For a good many years it has been the firm conviction of steelmakers that blast furnace hot metal was unsuited as a charge material for the arc furnace. However, one steel company has been working along the lines of gradually increasing the hot metal charge in their arc furnaces to the point where they, today, can regularly take 50 per cent hot charge in blast furnace metal. They find there is a reduction of about 6 per cent in the power used and an increase of 10 per cent in hourly output.

This is mentioned merely for the fact that it has long been argued that such practice, using 50 per cent hot metal in an arc furnace, was dangerous indeed due to the violence of the boil when it took hold. It is interesting to note that this steel company has, by changing some of the procedure, developed a practice where violent boils are not had and the whole operation runs along very smoothly.

While this work has been done in furnaces of smaller size than we are discussing here and the limit of hot metal has been 50 per cent, with the larger size furnaces under discussion, greater percentages of hot metal could be used.

Another factor that has just appeared over the horizon is the possibility of producing electric furnace pig iron for 1000-kwhr per ton in contrast to the usual 2000 to 2500 kwhr per ton developed through the long use of electric pig iron smelters in northern Italy and Scandinavia.

One of the chief difficulties with the older electric pig iron furnaces was, due to electrical limitations, about the largest furnace that could be built was a 200-tons per day furnace powered with 25,000 kva. Now 200 tons per day is too small an amount of pig iron to be a real factor in steel production. If this new development proves itself, then that same equipment immediately becomes a 500-ton per day plant and with two such furnaces you have 1000 tons per day of pig iron, which is worth giving serious consideration.

Work on this process has been proceeding in this country and in Scandinavia and holds promise of permitting serious consideration of the production of electric furnace pig iron in areas where, under the old type of operation, such an installation was not economical.

Again, BISRA in England has been working on a very high temperature direct reduction of iron ore, reducing iron ore directly to steel. To my knowledge, no detailed data have been published on this as yet, but from the temperature involved it would look as though there would be serious refractory troubles if any great tonnages were attempted.

Finally, we are living in a fast changing era. The steel industry has for years been known for its inertia or resistance to change. We well remember, not too many years ago, where top management compelled the

installation in a new plant of a two-high bar mill, duplicating a mill that had been in operation in the parent plant for 37 years.

That type of thinking has been and is rapidly passing out of the picture. What we are interested in is better and cheaper raw materials for the making of steel. The blast furnace is a highly efficient unit but its investment costs have risen to a point where only the larger companies can give it consideration and the future should hold some other means for getting tonnage of charge materials for steelmaking from ore without the investment required in the blast furnace.

There is no question but that if the chemists and engineers continue their developments in producing a charge material directly from ore at prices competitive not only with scrap but with pig iron—and every indication points to their success in this endeavor—then the electric furnace has a brighter future ahead of it.

The electric furnace as a producer of steel is the most practical melting medium available to the industry. It has lower capital cost and better return on investment, and it handles the sulphur problem and avoids trouble from high sulphur fuels. It is also tops in "off" and "on" economy, can be shut down over a weekend or a holiday. It can be operated on a five-day, single-shift operation or a seven-day, two or three shift with equal facility.

It has high thermal efficiency and in that connection we should consider the relative cost of fuel for the arc furnace. In the face of increasing costs of other types of fuel, the cost of electric energy has dropped or has held level.

What the future holds for atomic energy production remains to be seen—England has already gone into operation on a commercial scale—but in the over-all picture for the future, we feel the large electric furnace will be an increasingly important factor in the production of common quality steel.

DISCUSSION

PRESENTED BY

RUSSELL J. MacMULLAN, Hydro-Carbon Research Corp., New York, N. Y.

W. B. WALLIS, President, Lectromelt Furnace Division, McGraw-Edison Co., Pittsburgh, Pa.

G. R. HEFFERNAN, Managing Director, Premier Steel Mills Ltd., Edmonton, Alberta, Canada

E. S. HARMAN, President, E. S. Harman Corp., Chicago, Ill.

Member: I would like to ask if Mr. Wallis has given any thought as to the influence of using H-iron, produced from low-grade ores, on electric furnace performance and on ingot costs?

Russell J. MacMullan: Our company, together with the Bethlehem Steel Co., have been developing successfully this iron reduction process to which Mr. Wallis refers.

The previous discusser asked: "What types of ore (i.e., what grades of ore) were best used in the process and, if low grades of ore, what was the extra power consumption?"

The only ores actually run in electric furnaces, have been high grade ores. They have been low in silicate. So, at the moment, I am not able to give the answer you might like to have.

I have been given the opinion by some of the foremost electric furnace people in Europe, and I believe Mr. Wallis might back me up a little bit, to the extent that he sees fit, that he feels there is the possibility of higher silicate ores being used in an electric furnace, although heretofore it has been the thinking, as I understand it, that any time the steel industry gets anything over two per cent it is looked at with a pretty jaundiced eye.

Obviously, it would seem to me that there must be some higher power consumption with the higher slag content. However, I think it then comes down to a matter of dollars and cents, as to whether or not what you are trying to do is more or less economic with the use of those high gangue ores. We are coming to lower ore grade uses in this country, and I can only say that, although we have not run them in electric furnaces, we are planning to do so.

They are already being scheduled to go through the Trenton plant but, until they are, I can only give you the answer that they have not as yet been run. Our European friends advise us that a sponge iron with as high as 10 per cent silicon can be run in a 50-50 mixture—scrap and sponge. It is their practice to take a pre-flush slag at low temperature and thus renew most of the gangue. By this method, power costs are reported to be increased 5 to 10 per cent; time of heat about 5 per cent; through-put decreased only about 3 per cent and lining and electrode life decrease only negligible.

W. B. Wallis: There was a question asked here that I did not quite understand. You were talking about what would happen in the arc furnace if you used this iron with low Fe content, with a lot of fluxing to it? As stated in the paper, the Fe is 85 and 95 per cent and you are not faced with heavy slag with that kind of metal. Now Mr. MacMullan is saying their runs have been made on high grade and not low grade.

Russell J. MacMullan: With high grade ores, yes—but we still can not answer your question. Truly, I do not think we know what the effect of this high gangue content in H-iron will be in the electric arc furnace until it is tried, but other "sponge irons" used in Europe appear to be acceptable even with a high gangue content.

G. R. Heffernan: I understand that in Germany they are using the Krupp-Renn process. They are producing a product from high silica ore—it runs about 92 to 95 per cent iron, and probably up around 2 per cent carbon. I wonder if you have had any experience or would like to comment on the use of that material for electric furnace charge?

W. B. Wallis: The only information that I have is that, with the Krupp-Renn process, they are using a high gangue sponge in basic electric furnaces, running 8 per cent silicon, but I have not had an opportunity of studying the practice.

E. S. Harman: Any Krupp-Renn plants in Europe operating at the end of the war were moved behind the Iron Curtain and I know of no installation of Krupp-Renn's supplying metallic charging stock for electric furnaces. There is one plant in Spain producing metallic for blast furnace charge.

PRODUCT QUALITY—Keynote of Drive Systems Engineering

By E. H. BROWNING
Manager, Metal Working Section
Industry Engineering Dept.,
Westinghouse Electric Corp.
East Pittsburgh, Pa.
and L. F. STRINGER
Manager, Mill Control Systems Development
Westinghouse Electric Corp.
Buffalo, N. Y.

. . . . newer forms of automatic controls will result in better product quality and more economical operation . . . . trend is to the use of magnetic amplifiers, use of component units, logic elements and transistors and punched card control . . . .

▲EVERYONE is aware of the tremendous demands being imposed upon the steel industry for larger quantities of finished steel products. The industry's capacity and production have soared to new heights, and it appears that the achievements accomplished to the present still are to be outdone in the future. Almost without exception, the producers in the steel industry are girding themselves for huge expansion programs. Amid the clamor for more steel by the user industries there can be distinctly heard the cry for better steel products and the insistence of this cry cannot in any way be discounted by those who must meet the demands for both quantity and quality. The adoption of the keynote "product quality" by the steel industry reflects greatly to its credit, particularly when it is considered that almost all product made at the present time can find its way to some market.

Since the majority of steelmaking processes require the use of electrical drives and power equipment, the electrical equipment manufacturer shares in the responsibility of the steel industry to produce better products for its customers. The electrical equipment manufacturing industry is exerting great efforts to help the steel industry achieve its objectives. It has provided steelmakers with the drives required for the continuous mills and processing lines which have made possible today's high quantity production. Now, much of the electrical manufacturer's attention is being directed to the many aspects of product quality.

New applications of advanced automatic control presently are coming into use in the steel industry to effect quality improvements, and it is expected that the future will see them to be the rule rather than the exception. Direct and indirect product quality monitoring systems making use of analog and digital computing techniques, logic elements, unique feedback circuitry and newly developed sensing and sampling equipments are being designed, tested and utilized to control and conventional electrical drive arrangements common to modern rolling mills and processing lines. A large number of these new forms of system control elements have their beginnings in a laboratory or on a simulating computer; but included among the design objectives most stressed is suitability for the rigors of industrial usage. The present state of development and availability of static, highly reliable components such as magnetic amplifiers, transistors and other semiconducting devices have done much to permit the progress made in accomplishing the desired objectives. Special emphasis is being given to investigating the many processes used by the industry so that those factors which affect quality of the product can be recognized, understood, and ways and means of controlling them determined. Thus it is that through all the phases of steel production—from the blast furnace down through the hot and cold rolling operations and through the finishing processing operations—investigations are being undertaken to make the interim and final products of more desirable characteristics. Some of the systems being developed and put to use in the industry today and those which will be put into use in the near future are undeniably somewhat more complex than systems formerly employed; however, the gains realized through improvements in quality resulting in the strengthening of competitive position and increased yields certainly warrant their fullest use.

Some automatic control systems take a direct or indirect sensing of the product being manufactured and trim or adjust the producing system such that noted deviations from the accepted final standard are continuously corrected. Other systems of quality control can be those of determining step-by-step exactly what the requirements are for each part of the process so as to yield a finished product of the quality

desired. Once a complete understanding of all of the factors involved is reached, then it becomes practical to program the operations such that duplication of results is always achieved and the process can be repeated time after time with a minimum or no deviation from previous runs. Naturally the product standards must be of such definition that the process can be economically operated and the manufactured product accepted in a market.

Automatic control equipment must be first of sufficient rugged capabilities that it can be handled industrially and maintained properly. It must also be in a pricing range where the gains to be achieved can be effectively used to write off the cost and ultimately show the user a profit.

Some examples will be given showing in their essentials some of the systems which have been evolved and which are in service in the industry at present or will soon be placed in service to work towards effecting an improvement in product quality and at the same time fitting into the high production volume requirements paralleling the quality requirement.

ELECTRIC ARC FURNACE REGULATING SYSTEMS

The electric arc furnace poses a fine example of an equipment flexible in nature and capable of producing highest quality steels. Of great importance in the operation of an electric furnace is the regulating system used to automatically position the electrodes during the melt-down and refining phases of a heat.

Figure 1 shows a schematic diagram of a magnetic amplifier arc furnace regulator. Here samples of arc current and arc voltage are compared in the regulator in such manner that should a deviation from preselected balanced conditions occur, an output from the magnetic amplifiers will be supplied to one of the generator fields and the electrode motor will position the electrode to restore balance. A current adjusting circuit is provided such that under manual operation the furnace operator can select the arc current to be maintained.

In making a heat of steel, a number of furnace transformer voltage taps are used. For a particular furnace installation, the power input conditions as a function of arc current for each tap voltage used can be determined by simple testing. Thus, the best or optimum point of operation of the furnace for each tap voltage can be selected, and a programming type system of operation can be applied by utilizing what is termed "optimum current control." Here, recalibrating resistors—the values of which are selected based on test results—are switched into the current adjusting circuit for each tap voltage used. The insertion of the proper resistor value into this circuit is accomplished automatically by relays which are interlocked with the furnace transformer tap changer mechanism. Thus, for each transformer tap, the arc current value to be regulated is set in the current adjusting circuit. This form of control makes it unnecessary for the operator to set manually current values corresponding to each of the melt-down taps used. Since this is done automatically, assurance is had that operation throughout the melting-down phase is proceeding under best conditions, and that duplication of the process is realized heat after heat. Through having selected and set the proper re-calibrating resistance values based on tests and experience, the refining phase of the heat can be carried through so that carbon pickup is eliminated and quality of the steel is unimpaired.

CARD PROGRAMMED AUTOMATIC SCREW-DOWN CONTROL FOR REVERSING MILLS

Preset automatic screw-down controls for reversing mills have been used for quite a number of years. Such controls have been of an analog nature and have

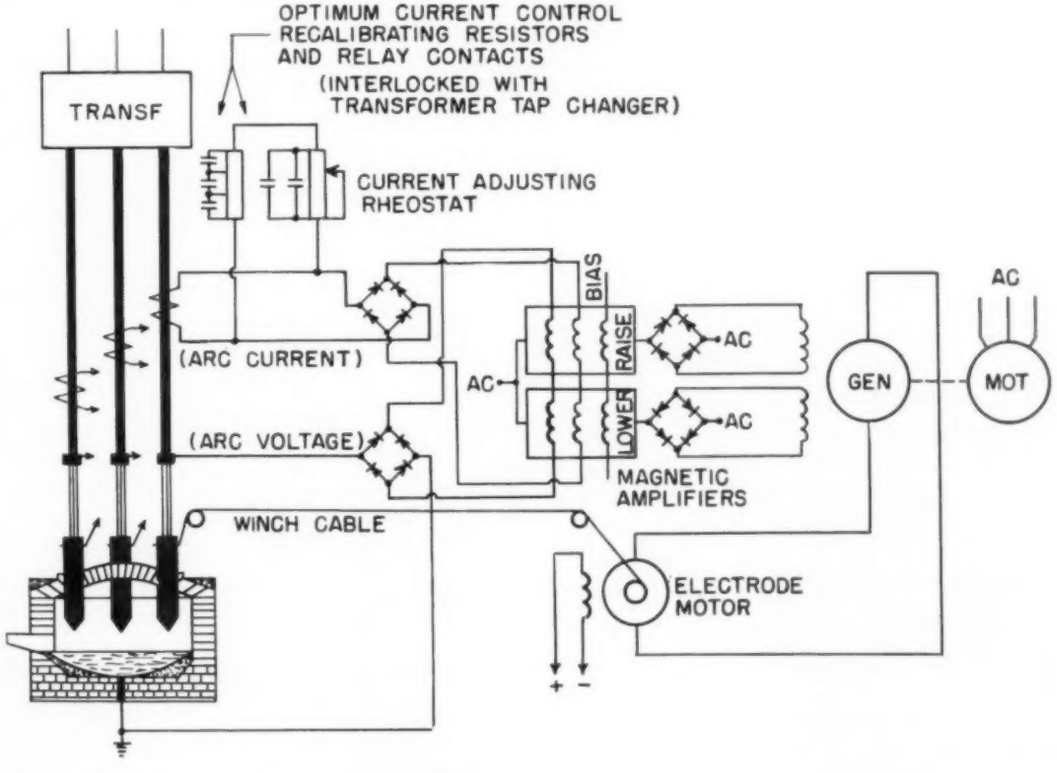


Figure 1 — Simplified schematic diagram of a magnetic amplifier electric arc furnace electrode positioning regulator.

DECIMAL NUMBER	=	BINARY NUMBER REPRESENTATION			
N	=	$C_n2^n \cdots + C_32^3 + C_22^2 + C_12^1 + C_02^0$			
0		0	0	0	0
1		0	0	0	1
2		0	0	1	0
3		0	0	1	1
4		0	1	0	0
5		0	1	0	1
6		0	1	1	0
7		0	1	1	1
8		1	0	0	0
9		1	0	0	1
10		1	0	1	0
11		1	0	1	1
12		1	1	0	0
13		1	1	0	1
14		1	1	1	0
15		1	1	1	1

Figure 2 — Tabulation illustrates basic method of representing decimal numbers in binary number form.

employed various forms of programming panels into which is set positioning circuit connections through use of plug-in type jumpers or sliders.

Although not in use in the steel industry as yet, a new form of automatic screw-down control which is programmed by means of punched cards will make its appearance approximately within the next year. This controller will be somewhat revolutionary in nature to the industry in that it will basically take the form of a digital computer. As such, the unit's operation will be based on using binary number system computing techniques. Also, it will make extensive use of transistor circuitry.

A general understanding of how such a computer controller will operate requires an acquaintance with both the binary numbering system and the operational use of transistors as switching devices.

Figure 2 shows the form of a binary number. Using the binary system, all decimal numbers can be expressed as a series of terms involving powers of the number 2; each term having a coefficient of either 0 or 1. Thus, a decimal number can be represented by a sequence of 0's and 1's. As an example, the number 5 can be represented as follows:

For the third power term, coefficient is 0, term value	= 0
For the second power term, coefficient is 1, term value	= 4
For the first power term, coefficient is 0, term value	= 0
For the zero power term, coefficient is 1, term value	= 1
Total series value	= 5

5 is then represented as 0101 binary number-wise.

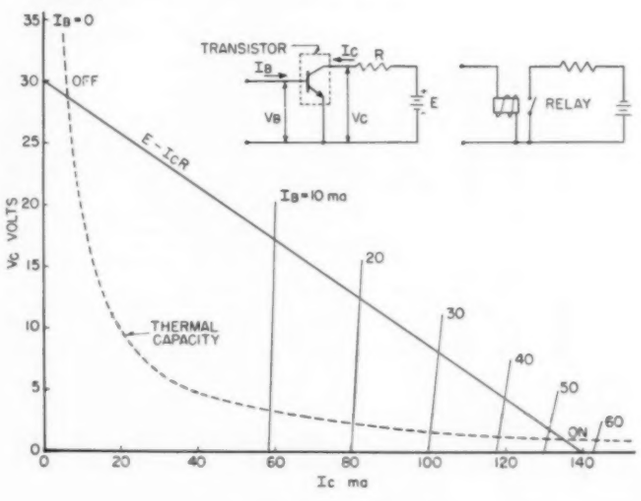
For numbers larger than listed, more terms are needed in the series expression.

Since each decimal number can be identified by discriminating between 0's and 1's, it is practical to represent each number electrically in a group of circuits. For illustrative purposes, in these circuits, the absence of current flow can be considered as representing a 0; and the presence of current flow can represent a 1. This method of representation makes it possible to use relays, vacuum tubes and transistors in a switching sense to convey intelligence representative of the more conventional decimal numbers. Further, by using the binary system, numbers can be added, subtracted, multiplied and divided through use of proper electrical components and circuitry.

Such a component, the transistor, is a semi-conducting device having three elements, one of which can be used to control the conducting characteristics of the other two. Semi-conductors have electrical characteristics which place them in a comparative region lying between conductors and insulators. The better known basic semi-conductor materials are germanium and silicon. To permit them to be used effectively, it is necessary to specially treat these elements by introducing into their structures small quantities of impurities. This "planting" of impurities results in the obtaining of the sought-for characteristics. As an example, consider that the specific resistivity of pure germanium is about 60 ohm-centimeters. Yet with the presence of as much as 0.0001 per cent of an impurity, the specific resistivity can be reduced to less than 0.10 ohm-centimeters. By using certain quantities of definite impurities, semi-conductor materials can be made to be rich in free electrons or deficient in free electrons. By forming junctions of these semi-conducting materials of dissimilar electron characteristics to form a three element transistor, a device is made available having properties making it suitable for use as a high speed, static switch or relay—devoid of contacts.

Figure 3 shows a representation and the characteristics of a simple transistor circuit intended for operation in the switching mode. The actual unit whose characteristics are graphically shown is about $\frac{3}{8}$ in. diam and $\frac{3}{16}$ in. high in physical size, and has a rating of 200 milliwatts as represented by the dashed curve. The solid line is a plot of voltage, Vc, across the transistor versus load current, Ic, through it for fixed values of input current, I_B, when connected to a resistance load, R, and a power supply, E. It will be noticed that if the transistor is operated along that part of the E-IcR line included inside of the two intersection points of that line and the dashed thermal capacity line, that the unit's power dissipation would exceed its 200 milliwatt rating. However, if the unit is operated outside these intersection points its thermal capacity is not exceeded. Thus, in the region marked OFF where the input current, I_B, is near or at zero value, the load current is very small even though practically the entire value of the supply voltage appears across the unit. In effect then the unit acts as a switch which is open. Similarly, in the region marked ON where the input current, I_B, is approximately 60

Figure 3 — Schematic diagram and performance characteristic of a transistor operating in the switching mode.



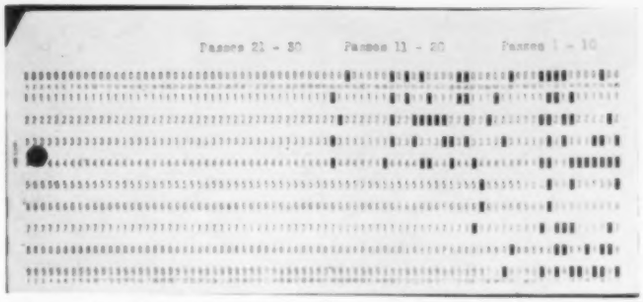


Figure 4 — This is typical form of a punched card used with digital type controls.

milliamperes, the load current, Ic, is of a high value even though the voltage, Vc, across the transistor is very low. In effect then the unit acts as a switch which is closed. In its essentials then, the transistor circuit shown operates quite similarly to the relay circuit shown. It is, however, smaller, faster and has no moving contacts requiring maintenance. When transistors are applied for operation in the switching mode just described, they are not subject to severe temperature restriction, and units of the same type are interchangeable.

Relating transistor operation with identification of a binary number, it is seen that a high value of input current, I_B, to a switching transistor can represent a 1 and a low or zero value of I_B a 0.

With this very brief treatment of the binary numbering system and the use of transistors operating as switches, consideration can now be given to the functional operation of the card programmed screw-down control. Figure 4 shows a typical punched card representing primarily the binary number coding for screw-down presetting and mill speed for a fifteen-pass schedule. Holes punched in the card represents 1's and spaces not punched represent O's. The physical dimensions of the card are approximately 3¼ x 7½ in. It will be noticed that only ⅜ of the card is consumed by the programming data, thus a good deal of space is left for other information—some of which can be of an accounting nature.

Figure 5 shows a functional block diagram of the card programmed automatic screw-down control. A punched card containing the digital information in binary number form relating screw-down position with the passes to be taken on the bar is placed into a card reader. The card reader reads the information into the storage element where it is retained for use on each pass made. When the screw position is to be set for a pass, the storage element supplies the digital information required to the digital difference detector. Connected for illustrative purposes to the mill's screw-down mechanical system through an arrangement of gears, synchro-ties and a clutch is an analog-digital converter. This unit supplies a digital signal of the actual screw position (roll separation) prevailing to the digital difference detector. The digital difference detector performs a subtraction process with the two signals—the one from the punched card and the one indicating the position condition of the screws. The difference, which constitutes the error in digital form, is supplied to the digital-analog converter. Here the digital error is converted into a voltage and supplied to a magnetic amplifier which in turn provides an error or command signal to the conventional adjustable voltage screw-down control. The result is that the screw-down drive positions the top mill roll until the separation corresponds to that desired and dictated by the information on the punched card. This process is carried through automatically as each pass is called for by the operator or by some other means.

With such a form of control, it is expected that interim product quality will be improved by virtue of the fact that more precise scheduling information for a bar may be quickly selected and used to match conditions of material temperature, composition and initial size. Cards to suit a range of conditions affecting rolling can be prepared in advance and selected as conditions dictate. Such a method of operation permits duplication of results through integration of experience factors into the programming data punched on the card. Also, the mill operators are relieved of some time-consuming chores and such time can be effectively directed to other attention-demanding duties.

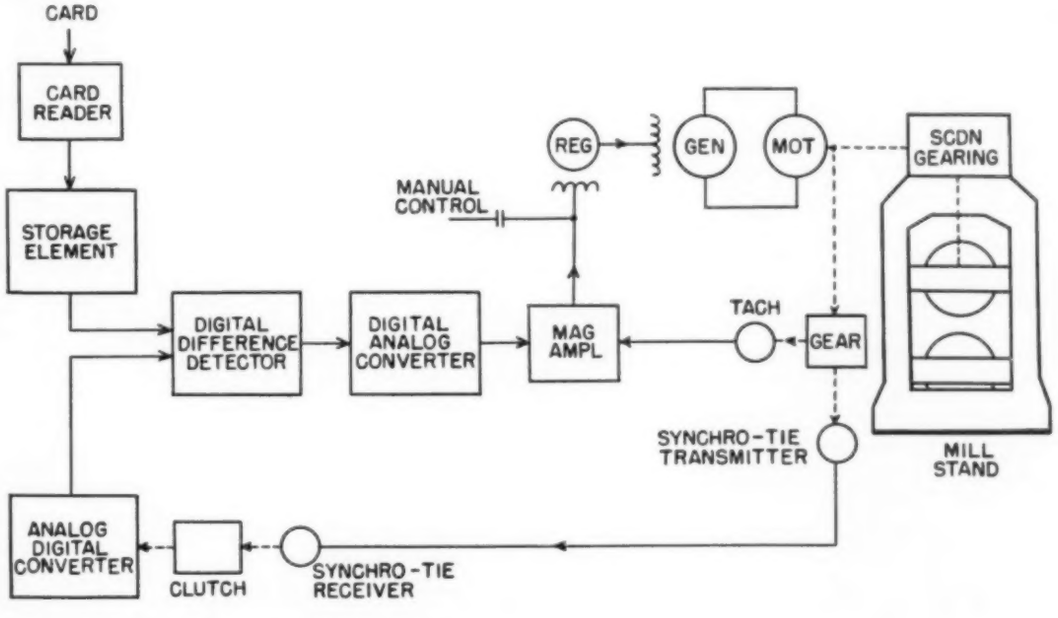


Figure 5 — Block diagram illustrates operation of a card programmed automatic screw-down control.

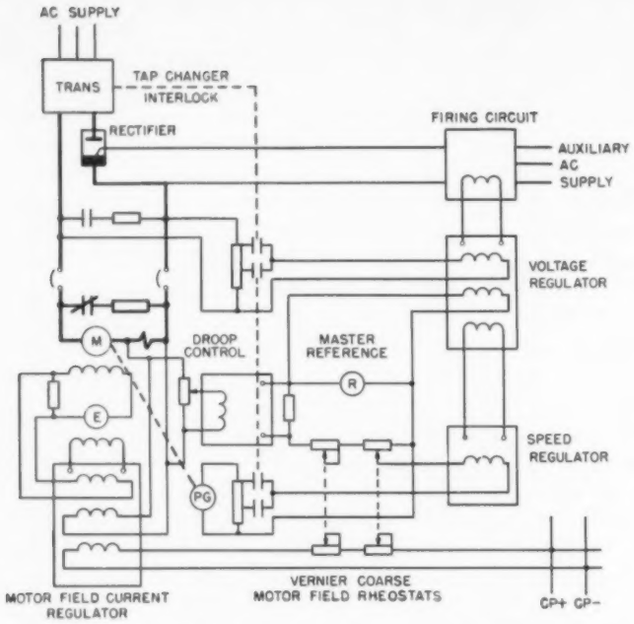


Figure 6 — Simplified schematic diagram shows a speed-regulated, individual, rectifier-supplied main roll drive.

HOT STRIP MILL CONTROL

Considerable effort is presently being directed to improving the quality of hot bands produced in semi-continuous and continuous hot strip mill finishing trains. The trend towards individually driven finishing stands for purposes of increasing flexibility is readily apparent. Attention is being given to extending the use of automatic controls for hot strip mills so that gage of product can be held to closer limits than has been the case in the past. Actual speed control of individual stand drives points in a direction to improve product quality.

Figure 6 shows a simplified schematic diagram of an individual rectifier supplied roll drive motor. This scheme consists of controlling the speed of the motor by operating on the armature voltage through control of the rectifier. Adjustable droop control is included. A master reference exciter voltage is compared with the voltage of a pilot generator driven by the stand motor. Any difference of error existing is supplied to a magnetic amplifier speed regulator which supplies intelligence to a magnetic amplifier voltage regulator controlling the firing circuit of the rectifier. This results in the adjustment of the rectifier voltage so that the speed of the motor is corrected. Incorporation in the reference circuit of adjustable droop control receiving its intelligence from stand load offers a means of fixing regulation of motor speed proportional to stand loading as may be desirable.

It can be expected control systems will be evolved for hot strip mills to include radiation gages, and programming and other features each designed to improve still further the quality of the product. The control just described will facilitate the provision of these features.

ROD MILL CONTROL

Control of single and multiple strand high speed rod mills with multiple motor drives must be quite precise to insure quality product. Since the bar is in a number of stands at any given time, and since the loads on the various stand drives change as a bar enters or leaves each particular stand, the speed relationships must be held within close limits to prevent necking down or the throwing of loops which can result in cobbles between stands. Speed matching regulating sys-

Figure 7 — Simplified schematic diagram shows control for a rod mill.

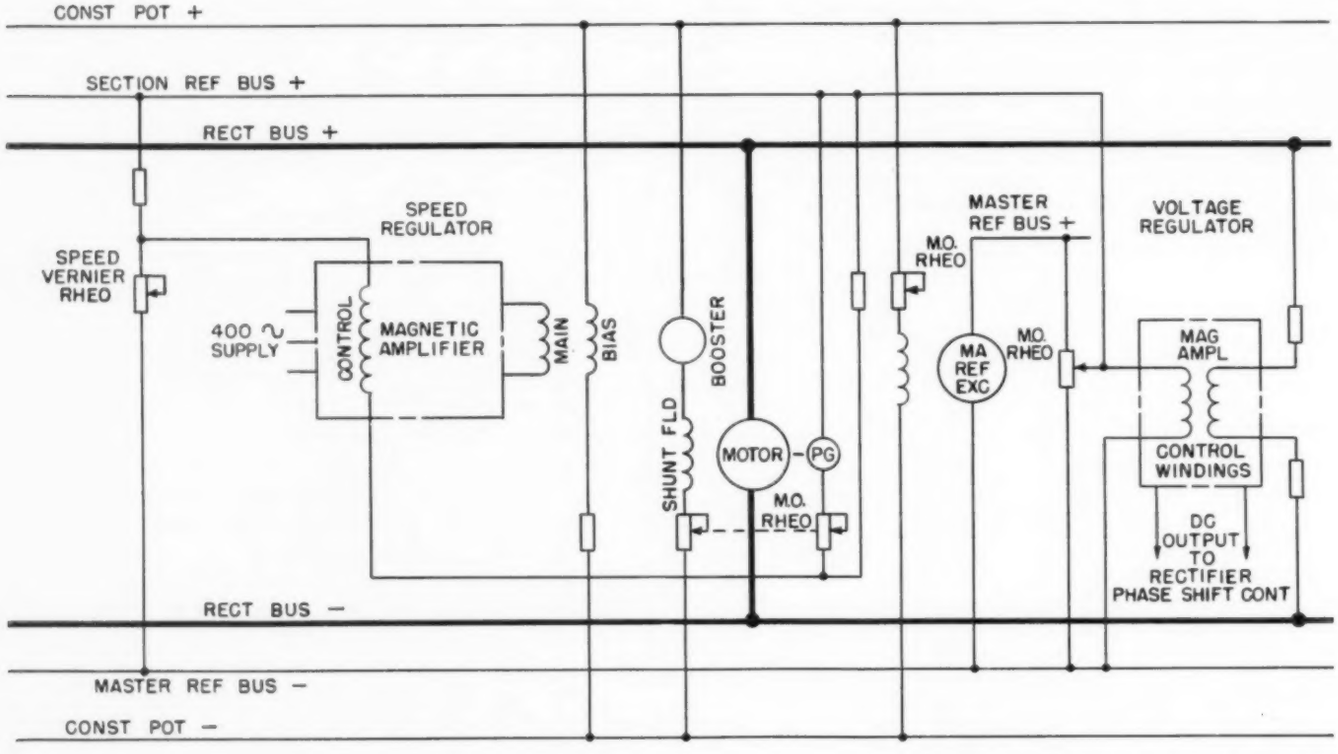


Figure 8 — Factory tests combination of equipment for use in a rod mill drive control system.

Figure 9 — Magnetic amplifier is used in control of tandem cold reduction mill.

tems are employed to good advantage to give the high speed recovery rates required. Also, motors of special design to yield low impact drop performance are applied to such mills.

Figure 7 shows a simplified schematic diagram of a speed regulating system for a rod mill drive. Here a number of drive motors are all supplied by a common rectifier bus. The output voltage of the rectifier is regulated to a value set by the reference by a magnetic amplifier which controls the phase shift of the rectifier's firing circuit. A second magnetic amplifier used as a speed regulator compares the reference bus voltage with that of the pilot generator driven by the drive motor. Any error existing is amplified and supplied to

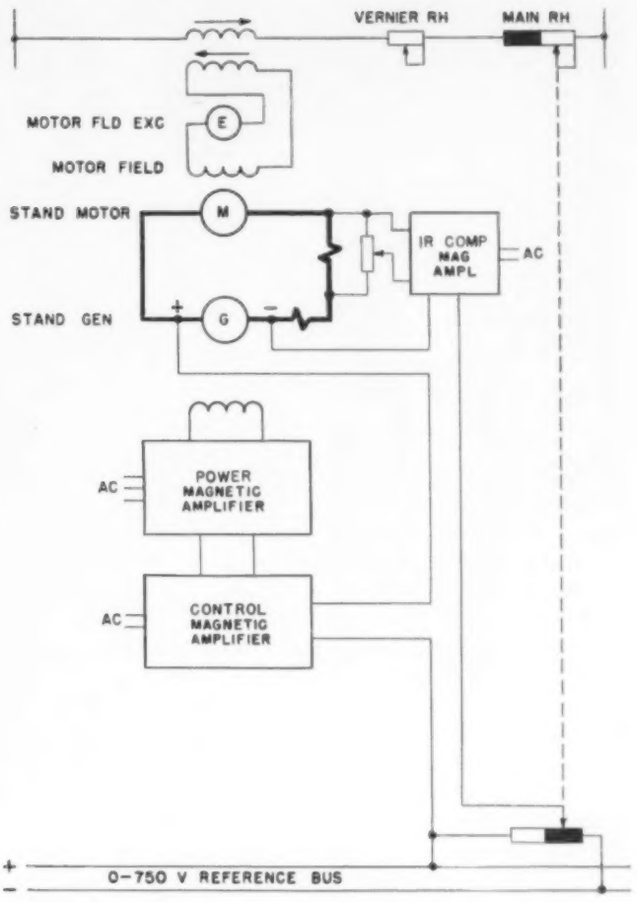


Figure 10 — Simplified schematic diagram of a magnetic amplifier stand drive regulating system for a tandem cold reduction mill.

a booster exciter in series with the field of the motor to force a flux change to cause correction of the motor speed.

Figure 8 shows a full-scale factory combination test setup for such a control system for a rod mill using equipment actually supplied for installation. Shown is the 3500-kw rectifier, its supply transformer, switchgear, rectifier voltage regulator and motor speed regulator equipment, and a drive motor mechanically connected to a tool or loading generator.

TANDEM COLD MILL CONTROL

A tandem cold reduction mill such as that shown in Figure 9 requires very accurate and well damped high response regulating systems for the individual drives associated with each stand and the reel. In order to turn out high quality product in large quantities, close speed and tension relationships must be maintained between stands during high speed steady state running conditions and during acceleration and deceleration. The particular mill shown was the first to be completely magnetic amplifier controlled so these results could be better realized. This mill was installed over two years ago and the maintenance-free performance of the drive system has been outstanding.

Figure 10 shows a simplified schematic diagram of the control for one stand of a tandem cold mill. Magnetic amplifiers are 400 cycle per sec. The generator voltage and the reference bus voltage (common to all stand

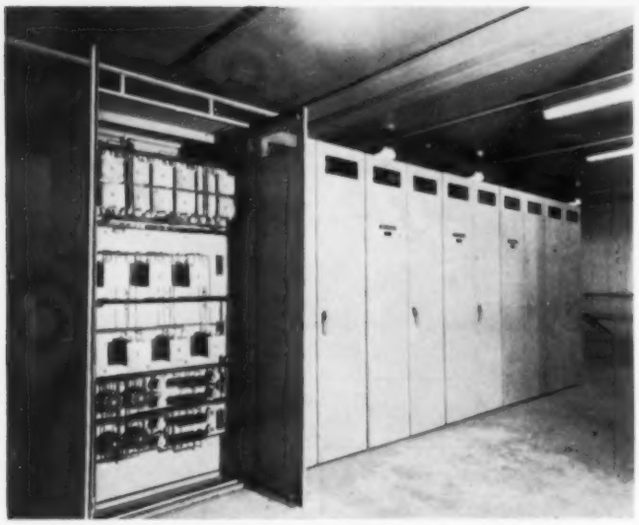


Figure 11 — Magnetic amplifier regulators, used for control of a tandem cold reduction mill, have little maintenance.

controls) are compared in a control magnetic amplifier. An IR drop magnetic amplifier is included in the comparison loop to compensate for resistive drop in the armature circuit so that generator voltage and motor speed are more nearly matched. The control magnetic amplifier supplies a power stage magnetic amplifier which provides excitation power to the stand generator. If the generator voltage should differ from the reference voltage, the excitation to the generator is rapidly changed by the regulator's forcing action to re-establish the desired matching condition.

Tests conducted on the mill shown in Figure 9 indicated the system could correct a 14-volt step function error with the motors connected to the generators and operating at 400 volts in 0.10 sec. Under steady state operation, the maximum error noted between generator and reference voltages was only 0.2 volts over a voltage range from 0 to 750 volts. Under such regulating conditions strip quality is held to a high level.

Figure 11 shows the enclosed, floor mounted magnetic amplifier equipment used with the mill shown in Figure 9. The maintenance of such static equipment has proved to be almost negligible.

Today, in further effort to improve product delivered by tandem cold reduction mills, the use of X-ray and radiation type gages for monitoring strip thickness are coming into use. These gages monitor strip thickness and work through control systems to correct such deviations as may occur. Generally, one gage is located immediately after the first stand and works to control screw settings on the first stand; and another is located after the last stand and works to adjust last stand motor speed and hence strip tension between the last and preceding stands. Results reported to date show considerable improvement in strip quality is obtainable.

TWO-STAND TEMPER MILL CONTROL

In temper rolling, the production of material of uniform quality is dependent upon the close regulation of strip tensions throughout the mill. The front view of a two stand, four-high, two-high temper mill is shown in Figure 12. The interstand tension on this mill is measured by means of a mechanical tensiometer system which provides a deflector roll displacement proportional to strip tension. This displacement is converted into an equivalent electrical signal which is supplied to a two-stage, two-channel magnetic amplifier as shown by Figure 13. This amplifier controls the speed of the first stand and hence the interstand tension by control of the first stand drive motor armature voltage.

Here again the magnetic amplifier is the heart of a high performance regulating system which permits the mill operator to have close control of an important process variable. By setting the regulating system to control this variable at values found by experience to

Figure 12 — Two-stand temper pass mill employs a regulating tensiometer between stands.

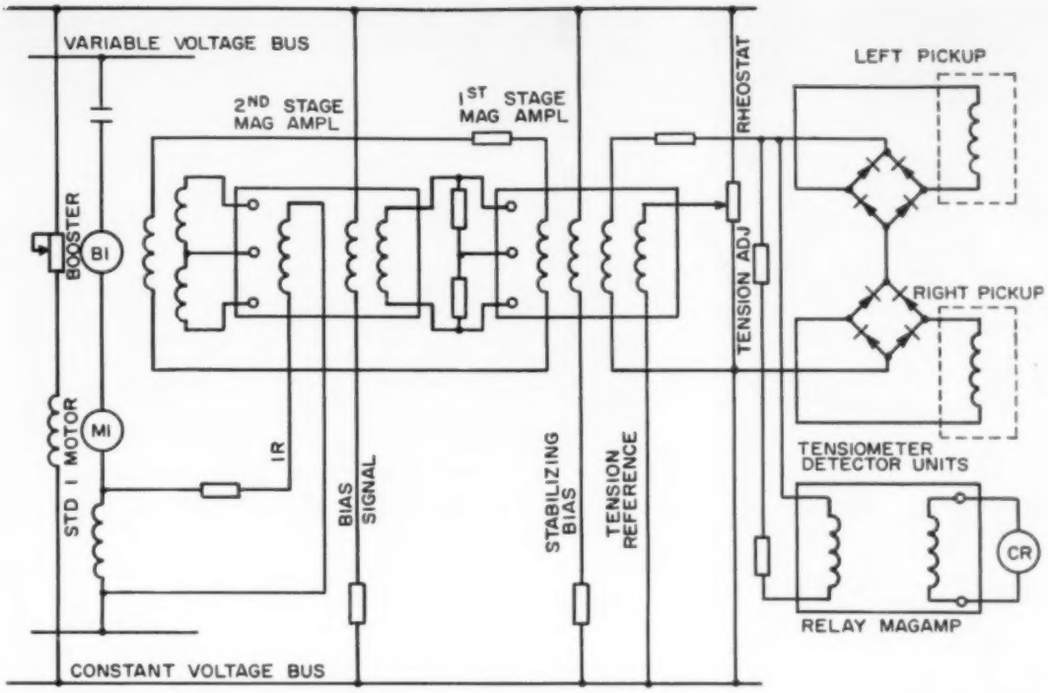


Figure 13 — Simplified schematic diagram for a regulating tensiometer control system used on a two-stand temper pass mill.

give the best results, high product quality can be consistently duplicated.

ELECTROLYTIC TINNING LINE CONTROL

The modern high-speed electrolytic tinning line, an example of which is shown in Figure 14, produces a product where high quality is a "must." A line such as this operates at speeds of about 2400 fpm, and the feedback control or regulating systems used—about twenty of them—must be of the best.

One of the most demanding control functions to be performed is that of regulating the power used to cause the electrolytically deposited tin coating on the steel strip to melt or "flow." This "flowing" process results in a bright, nonporous, corrosion-resistant surface suitably adapting the product for use in the manufacture of tin cans and containers.

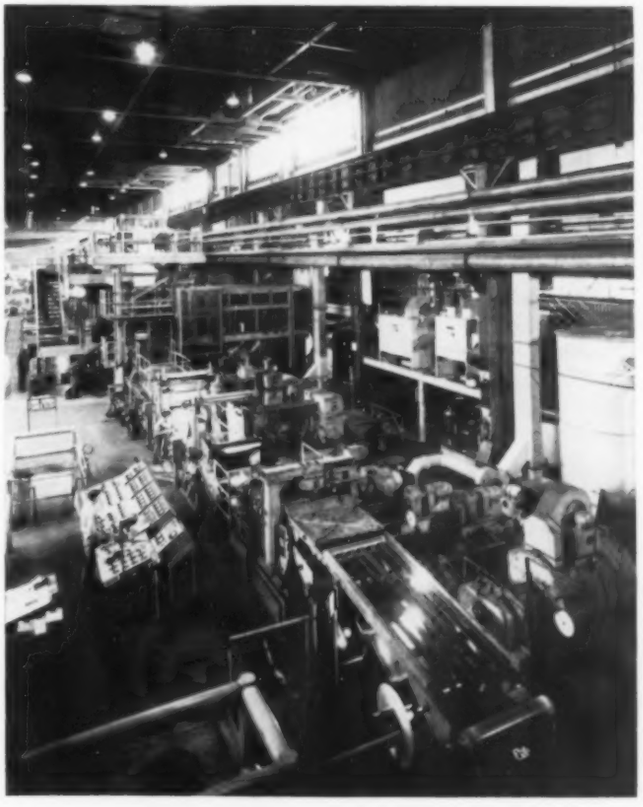
One extensively used method of accomplishing this tin flow process employs radio frequency power to heat the strip inductively to cause melting of the tin. In the tinning line shown in Figure 14 this is done by passing the strip through radio frequency inductor coils located in the tower-like structure in the background.

Figure 15 shows a closeup view of the strip passing through the inductor coils of one of the first tinning lines using induction heating. The line was placed in service in the early 1940's.

Using the induction method of generating heat in the strip permits input power densities of the order of 600 kw per linear ft of strip length. This means the strip can be brought to tin flowing temperatures in very short-length heating zones, and the time at elevated temperatures is minimized. This latter point is advantageous in obtaining desirable tin-iron alloy characteristics of the coating.

Figure 16 shows the so-called "flow line" or dividing line between the dull mat surface and the bright finished surface that exists during the induction heating process. Since this line of demarcation is well defined and quite linear, advantage of its characteristics can be taken to regulate the amount of power induced in the strip. Since the bright flowed surface reflects light while the dull mat unflowed surface diffuses light, an optical scanning system as shown in Figure 17 can be applied. Here, light from two sources can be focused on the strip at a definite level in the induction coil at which it is desired to maintain the position of the flow line. A photo-sensitive pickup unit is located as shown be-

Figure 14 — Delivery end of a high speed electrolytic tinning line which employs radio frequency tin reflow equipment.



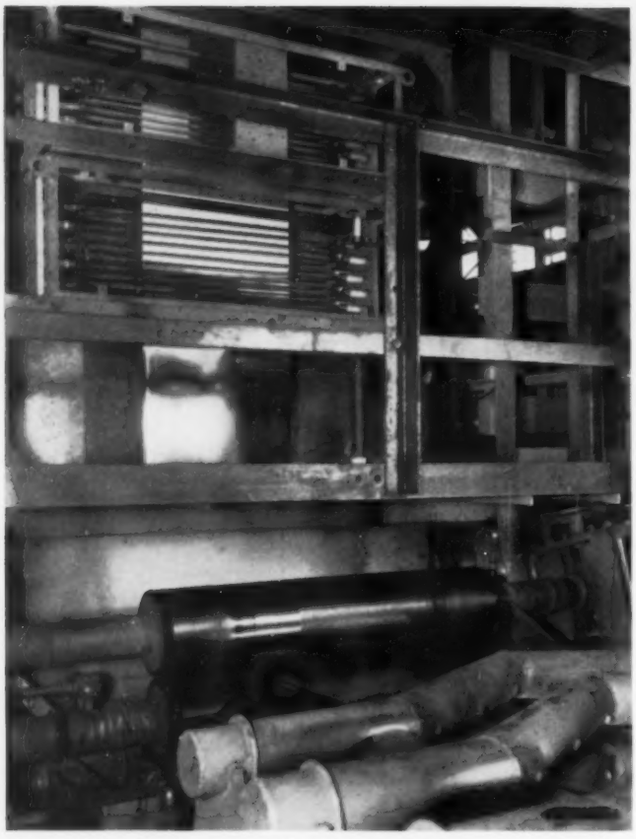


Figure 15 — Strip passes through a section of a radio frequency tin reflow inductor coil.

tween the two light sources. If the flow line exists at the desired level, the pickup unit receives a certain amount of light. If the flow line is higher in the coil than is desired, the light is reflected and less light is directed to the pickup unit. If the flow line is lower in the coil than is desired, the mat surface diffuses the light and more is directed to the pickup unit.

The electrical output of the pickup unit is amplified and a rectified signal is supplied to an exciter which controls a saturable reactor. This reactor controls the voltage to the rectifier transformer and thus adjusts the output voltage of the high voltage rectifier which

Figure 16 — A definite tin "flow" line occurs when radio frequency induction tin reflow methods are used.

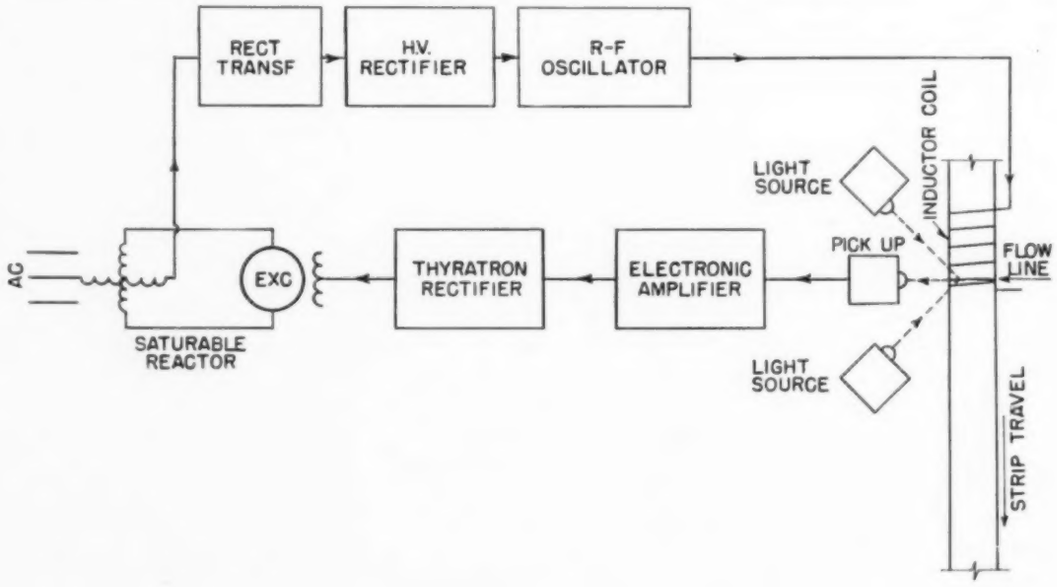
supplies the radio frequency oscillator. The net effect is to control the power to the inductor coil so that if the flow line position tends to progress upwards, less power is induced in the strip; and if downwards, more power induced in the strip.

With this form of control and the associated induction heating power equipment, electrolytic tinplate of the highest quality can be produced in large tonnages in a continuous line.

SUMMARY

These examples citing the part played by automatic controls in improving product quality are but a few of many. It is expected that automatic controls will continue to be developed for further automatizing existing processes and for application to new processes as they appear. The trend is definitely towards the use of control techniques suitable for broad application and the use of functionally unitized components. Such design objectives are aimed at facilitating maintenance and replacement of component blocks as newer and better components appear. Electromechanical or contact-type regulating systems gave way to those employing rotating regulators. Now, magnetic amplifiers are vying for the position established in the

Figure 17 — Block diagram illustrates operation of the tin flow line scanner system.



past by the rotating regulator. Magnetic logic elements and transistors are now arriving on the industrial control scene, and most certainly their use will be rapidly extended. The static nature of such equipment offers tremendous promise.

Those automatic controls in use today in the steel industry for controlling high-speed continuous mills and processing lines and other special quality demanding operations are giving performance deserving of much credit. Those newer forms of automatic controls which will go into service tomorrow will give even better accounts of themselves.

DISCUSSION

PRESENTED BY

C. C. THOMAS, Manager, Construction Engineering Unit, General Electric Co., Schenectady, N. Y.

W. R. YORKEY, Sales Manager, Electric Controller & Manufacturing Co., Cleveland, Ohio

E. H. BROWNING, Manager, Metal Working Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

C. C Thomas: These men have written an interesting paper briefly reviewing some of the achievements obtained by co-operation of equipment manufacturers and the steel industry in the field of quality control. Basically I am in agreement with the major portion of the paper. As a matter of fact, it would be difficult to be otherwise, since a good portion of the paper describes applications which so far as I know only our company has in successful operation. No credits were given in the paper on any of these applications. However, to the uninitiated, it would appear that these were all developments of the author's company.

For the record, I feel obligated to point out that the only hot strip finishing mill with an individual rectifier per stand in operation at this time was supplied by my company at the McLouth Steel Corporation's Trenton plant. The only hot strip mill with speed regulators in operation is equipped with our equipment, and is located at the U. S. Steel Co.'s Columbia-Geneva Division Plant at Provo, Utah. I assume the automatic gage control for tandem cold strip mills, described in this paper, refers to the U. S. Steel Corp., Irvin Works, as I know of no other successful installations to date (April 30, 1956) using these principles.

Mr. Browning states "although not in use in the steel industry as yet, a new form of automatic screw-down control which is programmed by means of punched cards will make its appearance approximately within the next year." I assume he is not referring to the equipment already designed and manufactured by my company, which has been shipped to AlleghenyLudlum and is awaiting installation at this time. This particular equipment differs slightly from Mr. Browning's description in that on this application the input information is in decimal form on the punched card.

We do agree that in the future more and more systems of this general type, designed for industrial service, will be installed. They will be more complex and require a higher caliber of maintenance than many of the systems now in use; but if the more exacting requirements of the future are to be met, systems similar to these will be necessary, and high quality design by the manufacturer, coupled with high quality maintenance by the users, can make such equipments practical.

W. R. Yorkey: Mr. Browning's remarks on the preset screw-down, only confirms the things which we have been saying for many years; that it will improve quality and will leave the man free to do other things in the pulpit.

Actually, we recognized that problem many years ago, and we built and installed the first preset screw-down control in 1936. At the present time we have in operation, I would say, about 12 or 13 of these equipments in the nonferrous industry and about 25 in the steel industry.

Now, those have been applied to various types of mills and the setup system that we use, as Mr. Browning indicated, consisting of plug-in and slider panels, has been modified and improved over the years. After all, you start out with an idea and then you start to improve it.

I am not familiar with the process of converting from decimal to binary codes, but it does seem that there is a lot of equipment there to accomplish a result which can be done in a relatively simple manner.

Now, as far as the card system goes, we have recognized the need of that; we have had many inquiries for card systems, and we are working on such a system. It will not be what Mr. Browning describes but it will be a rather simple plastic card, about as thick as a playing card, roughly 9 in. wide and perhaps 5 in. high. The desired schedule will be punched on this card and it will be direct reading—that is, you can read the setting for each pass directly from the card in $\frac{1}{16}$-in. or $\frac{1}{8}$-in. increments or whatever minimum increments are provided. All one has to do to set up his schedule is to punch a card which when inserted in the card reader transmits the necessary signal for each pass setting and the rolls will move to the desired position. These cards can be changed quickly and the same card used over and over.

That card will replace the present slider panel and we feel that since we have behind us a proven system of operating preset screw-downs on about 40 satisfactory installations that we should stick to what has been proven good over the years, but work in improvements as we see they are needed.

You can get a total, roughly, of 900 stopping positions on these preset screw-downs and the increments of stopping depend on the total roll movement.

We have an installation on a 32-in. bloomer and the total roll movement is 29 $\frac{15}{16}$ in. On that the increments are 1/16 in., which is all that the customer needs for his particular application.

One of the questions we ask is: How accurate an operation do you want? If it is an edger, $\frac{1}{8}$ in. may be enough. If it is a bloomer, may be $\frac{1}{16}$ in. However, all of these things have been worked out over the years and we do not use some of the things which Mr. Browning discussed, storage elements, digital analog converters, comparison circuits and other devices. There were four of them that I counted, and those are not necessary to obtain an entirely adequate means of preset screw-down control as proven by the many installations that we

now have and on which you work directly with inches and fractions of an inch without the necessity of converting these settings into decimal figures.

E. H. Browning: Mr. Thomas has brought up the point of giving credit where credit is deserved. The electrical manufacturers have done very much over past recent years in bringing forth automatic controls which can be and are being utilized in the steel industry to help that industry increase its productivity. Aside from the electrical manufacturers, of course, the steel industry itself is making great steps forward in applying automatic controls. Many of the steel industry producers are doing extensive work to analyze their processes more fully and thus open up areas in which automatic controls can be most effectively used to improve not only their production but their productivity and their product quality.

Mr. Thomas has carefully itemized those projects of a development nature upon which his company has worked. It certainly is not our objective to minimize the importance of any group's efforts to advance the technology of metal rolling operations. Our reference in the paper to speed controlled hot strip mills and individual rectifier power supplies was not made to conclude that such arrangements constituted an end of a progressive program but rather a beginning of a program which ultimately would permit the use of programming methods and automatic gage controls. Regarding automatic gage controls for tandem cold reduction mills, our company is presently building a system as described in the paper for a 6000-fpm, five-stand mill. The reference in the paper made to automatic card programmed control for rolling mills pertains for the most part to equipment being built for a reversing roughing mill for the Jones & Laughlin Steel Corp. This mill will be fully automatic in that after initiation of the first pass by the operator's pushing a button, the mill will run through a complete rolling sequence of the required multiple number of passes and deliver the bar ready for the finishing train.

Certain of the new forms of controls which are being applied in the steel industry at first glance might seem to be considerably more complex than some of the controls used in past years. This is only natural insofar as most of the new controls are called upon to perform many more functions than their antecedents. These newer forms of card programmed controls certainly have a new look. However, there is really no reason why their usage should be limited. In the long run it will probably be proved that the maintenance requirements for such new forms of equipment is considerably less than for equipment presently in use and with which maintenance personnel are more familiar at this time. As the industry becomes more familiar with these new forms of controls, some of the mysteries of them will very fast disappear and their advantages—both operation-wise and maintenance-wise—will be recognized. One very basic concept used in the design of these new controls is that of employing static components. This in itself should minimize maintenance requirements. In the particular case of the card programmed control for reversing mills described in the paper, several maintenance check procedures and devices are built into the control to serve as an aid in verifying proper operation or any faults which might occur.

Mr. Yorkey's comments were very interesting and the modifications in automatic screw-down controls which he covered shows there has been a progressive need for better controls for this purpose. I would like to point out that our company installed its first automatic screw-down control in the steel industry back in 1926 on a beam mill located in the Pittsburgh area. We believe this particular installation which actually consisted of six automatic screw-down controls was the first utilized in the metal rolling field. The automatic screw-down controls used up until the present have been those in which the information for setting up the circuits has been preset by means of plug boards and slider contact arrangements. As Mr. Yorkey has pointed out, some form of punched card system can be devised whereby the information punched on the card is not in digital form, but is in a form which will permit contacts to ultimately make or set up circuits as a sequencing arrangement dictates. In a sense, then, such a punched card does very little more than provide a means for selectively connecting circuits. The advantage of the punched business card and the use of the digital coding method described in this paper or similar methods is that the type of information can be integrated into the accounting system which may or will be used in conjunction with the operation of particular mills. Further, the possibilities for obtaining higher accuracy from the type of control using digital techniques is greater than that which can be obtained easily through use of a straight analog form of control. On primary mills, extreme accuracy of setting of the rolls in the mill is not necessarily required in every case or even in the majority of cases; however, these forms of controls will make their way into rolling mill and processing operations where exceptionally good accuracies are required. Thus we cannot make light of the fact that the use of digital type programming controls is a step in the right direction. Certainly the result will be that industry will have at its command some controls which are much more flexible and more accurate than controls which have been used in the past.

AISE WESTERN MEETING

February 24, 25, 26, 1958

Hotel Statler **Los Angeles, Calif.**

. . . . disposal of plant wastes is one of the most difficult problems which the steel plant engineer must meet . . . . requirements are often set by outside agencies, meeting them adds costs which usually cannot be fully recovered . . . . the following article provides a manual which steel plant engineers will find extremely valuable in considering their waste problems . . . .

The Treatment of Water-Borne Wastes from Steel Plants

By ROSS NEBOLSINE
President
Hydrotechnic Corp.,
Consulting Engineers
New York, N. Y.

▲ WASTE treatment does not produce steel or simplify the operation of a steel mill. For the operators, it is an added chore; for the engineering department, it is a tangle of unfamiliar problems; and to management and stockholders, it represents a demand for capital outlay that usually cannot be economically justified.

Nevertheless, the steel industry recognizes its responsibility to improve waste treatment and is cooperating closely with the authorities charged with pollution regulations.

The following paper covers waste products with particular emphasis on steel plant problems. The waste products discussed are: flue dust, mill scale and free oils, soluble oils, waste pickle liquor and phenols, and also granulated cinder, which is in a special category. Miscellaneous wastes, such as result from ferro-alloy production, oxygen converter dusts, metal plating, cyanides, palm oil, etc., must be omitted for lack of space.

Based on an annual U. S. production of 120,000,000 ingot tons, the industry produces between 7,000,000 and 8,000,000 tons of water-borne wastes annually. These waste products are carried in over 10,000,000,000 tons of water. If all wastes flow were segregated, the amount of water would be reduced to about 7,000,000,000 tons per year.

Until now, steel, as well as other manufacturing plants, have been concerned mainly with getting rid of wastes recovering only that portion that can be done in the simplest and least expensive manner. In the future, however, more comprehensive facilities will have to be provided for controlling continuously the wastes loads in final effluents. The basic question is: how can this be effectively done with the least investment and the lowest operating expense. In answering these questions, only the principal wastes discharged with water by typical integrated mills of 1,000,000 to 4,000,000 tons annual capacity can be covered.

The number, characteristics, and quantities of water-borne wastes from any given steel plant are determined by the component production elements, the basic processes used, and the equipment involved. Each mill must be studied carefully to determine the special methods which can be devised to assure that its discharges meet required effluent standards. If this is for an existing mill, such studies and the construction operations must be carried out without interrupting manufacturing operations. Advantage should be taken of any savings possible. For instance, increased recovery of flue dust and mill scale might lower over-all costs, so might the recovery of other materials such as pickle liquor. Also, the cost of cleaning out the sewers and obligatory dredging of depositions in the water body can be diminished.

Nevertheless, it can be foreseen that the cost of meeting anti-pollution regulations, involving as it will, larger and more complicated treatment equipment and operations, will increase the total cost of producing steel. Various estimates of the incidence and amount of these charges will be discussed at the conclusion of this paper.

POLLUTION CONTROL CRITERIA

Setting quality standards for industrial effluents is a complex problem. It is under active study and deliberation by various sanitary and pollution control authorities throughout the country. Since conditions differ from area to area and plant to plant, no hard and fast, or universally applicable standards have been, or should be, established.

For example at one extreme, a plant may be situated along the coastline, far from any beach or center of

population, or located on the banks of a large stream with heavily silted water of poor quality. In such cases, where the general welfare would not be adversely affected the effluent quality standards could be quite low. On the other hand, a plant located on a river a few miles upstream from a municipal water supply intake, especially if the stream has a small discharge, can expect much more stringent waste treatment requirements.

Notable work in the field of treatment methods and standards has been done by the Ohio River Valley Water Sanitation Commission (ORSANCO). This large and important area has been divided into zones, each of which has its particular conditions and requirements. Suitable quality standards are being evolved for each of the zones.

Typical standards for a regulatory body in generalized and simplified terms might be as follows:

a. Discharges must be free from objectionable sludge-forming solids; free from unsightly or deleterious floating debris; and free from materials creating odor or color nuisances.
b. Suspended solids should be limited to 10 grains per gallon (170 parts per million).
c. Oil content should be limited to 30 ppm.
d. Phenol concentrations should be controlled so as to prevent nuisances downstream in water supplies.
e. No more than say 25 per cent of all acids used by an industrial plant should be discharged.

Such criteria are not complete and are subject to evolution and change. However, they give some idea of the improvement in the quality of effluents that steel plants will probably be required to achieve in the coming years.

Each section of the country will develop its own regulations. In the opinion of some engineers it is important that all such criteria remain flexible to allow for such factors as available dilution, natural assimilative capacity of the stream at a given point, the stage of the river, proximity to intakes of community water supplies and other particular conditions of a site.

Thus far, stress has been laid on improvements in waste treatment which may be required by anti-pollution authorities. There are, however, a few steel plants, not only on the Pacific Coast, but in Ohio and Maryland, where the degree of treatment certain wastes receive is determined, not by anti-pollution considerations, but by the quality desired of the water recirculated within the plant. Where fresh water is extremely scarce, it must be thoroughly treated for repeated use by various departments, each of which has successively lower quality requirements.

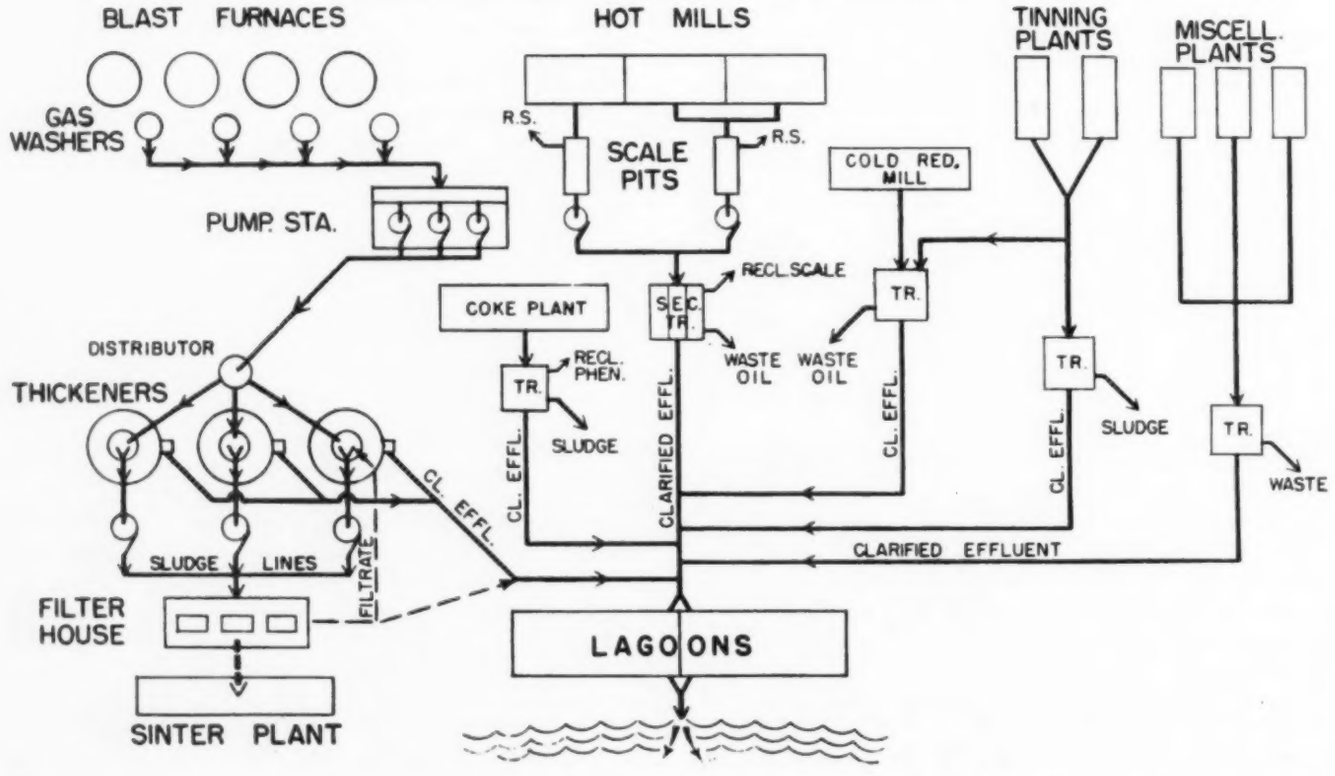
DESIGN OBJECTIVES AND BASIC LAYOUTS

The design of wastes treatment facilities for new steel plants is much easier than for existing ones. For in existing plants, problems arise both in finding space for the installations and in building them with a minimum of interruption of the steel production activities. Unfortunately, entirely new steel plants are rare. This discussion will, therefore, be directed primarily to improving wastes treatment in old steel plants.

The following list of design objectives will give an idea of the unusual number of conflicting demands which must be given consideration before the best solution can be found.

a. Adequate waste treatment performance.
b. Minimum first cost, which includes maximum utilization of existing wastes handling facilities.
c. Non-interference with steel production operations.
d. Minimum space requirements.

Figure 1 — This layout is desirable when space is available for centralized treatment of waste.



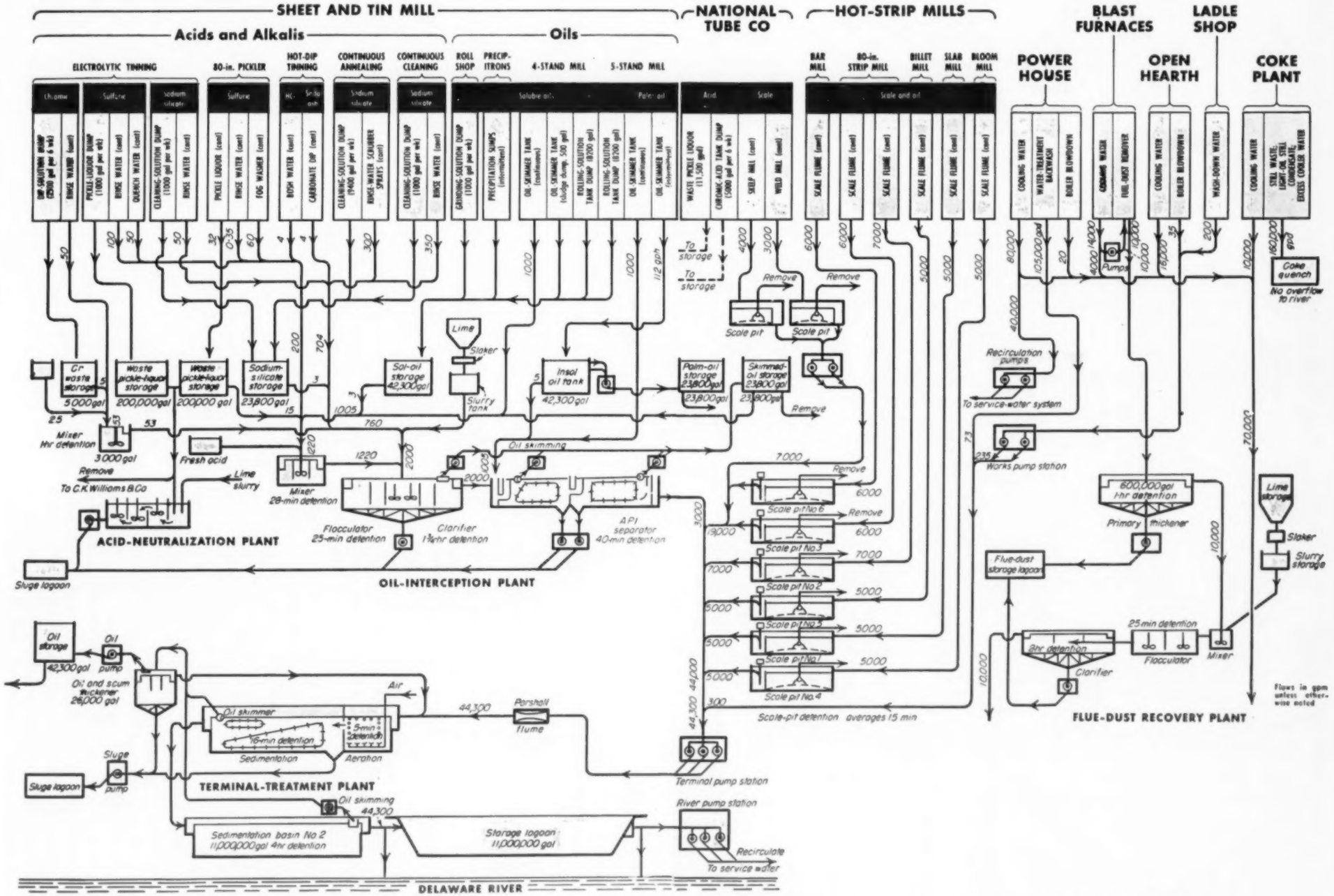


Figure 2 — Diagram shows treatment and disposal system for waste at the Fairless Works. This layout includes the latest thinking in plant design.

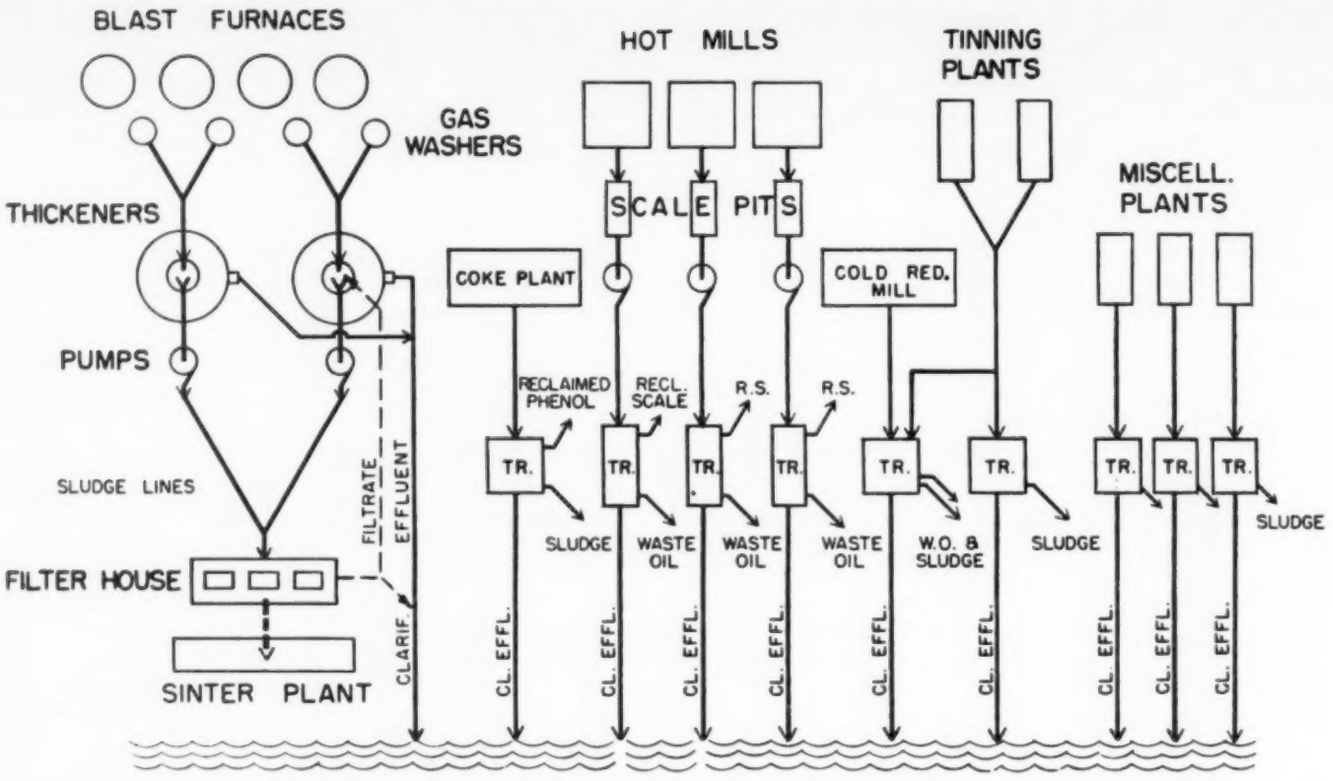


Figure 3 — Decentralized layout is used when adequate space is not available for large treatment works.

e. Minimum requirements for labor and supervision, i.e., automatic and flexible operation.
f. Minimum consumption of power, materials, parts and supplies.
g. Maximum recovery of utilizable materials.
h. Elimination of sewer cleaning and waste dredging operations.
i. Provision for expansion in treatment capacity in case of increased steel production.
j. Provision for meeting, at minimum additional expenses, future stricter effluent quality criteria.

To discuss wastes treatment problems that are most likely to interest the engineers and operators in the industry, and determine the over-all program, let us consider a typical integrated steel plant. Some of the governing factors are as follows:

a. Is it a new or an existing plant?
b. Is there space available for central or terminal treatment plants, or is the plant so crowded, or so stretched out in a narrow ribbon, that the collective interception of a number of discharges and their collective treatment is not practicable?
c. What are the current quality criteria requirements and what are they likely to be in the foreseeable future?
d. Is the primary source of water supply sufficient, and if not, how much must be reused.

To illustrate how the answers to such questions will affect the basic layout and design of the necessary facilities, three simplified flow sheets will be discussed.

Figure 1 is representative of a plant where space is available for centralized treatment of wastes, as applied to secondary treatment only. There may even be a suitable site for lagoons, where wastes could be stored or treated at a minimum cost. An example of such a solution is the terminal treatment works at the Fairless Works. The more complete diagram, as originally worked out, is shown on Figure 2.

Figure 3 is representative of a steel plant where suitable and adequate space for large treatment works is not available and all the treatment must be effected close to the source of each waste. In such cases, it would be too difficult and costly to try to collect the various wastes for secondary and/or collective treatment at a distant location. Most existing steel plants, due to successive expansions and rounding out programs, fall into this category.

Finally, just for the sake of comparison, it may be instructive to examine Figure 4, which represents complete wastes treatment within the plant due to the scarcity of water, as it has actually been worked out at the Kaiser Fontana plant in California. In this case, waste treatment is done to create a water supply.

PRINCIPAL TREATMENT PROCESS

Before discussing the treatment of each of the wastes products, it might be helpful to review the process of gravity separation. It is the basic physical phenomenon used in the treatment of flue dust, granulated cinder, mill scale and free oils. Soluble oils, plating wastes and certain other contaminants after they have received chemical and/or other treatment are also subject to gravity separation.

Particles, or agglomeration of particles, consisting of solids or globules of liquid, such as oil, having a different specific gravity from that of the liquid in which they are immersed, will either settle or rise. The fundamental law, as determined by Stokes, that governs such separation is expressed as follows:

$$V = \frac{2gr^2\ (S_s - S_f)}{9\ n}$$

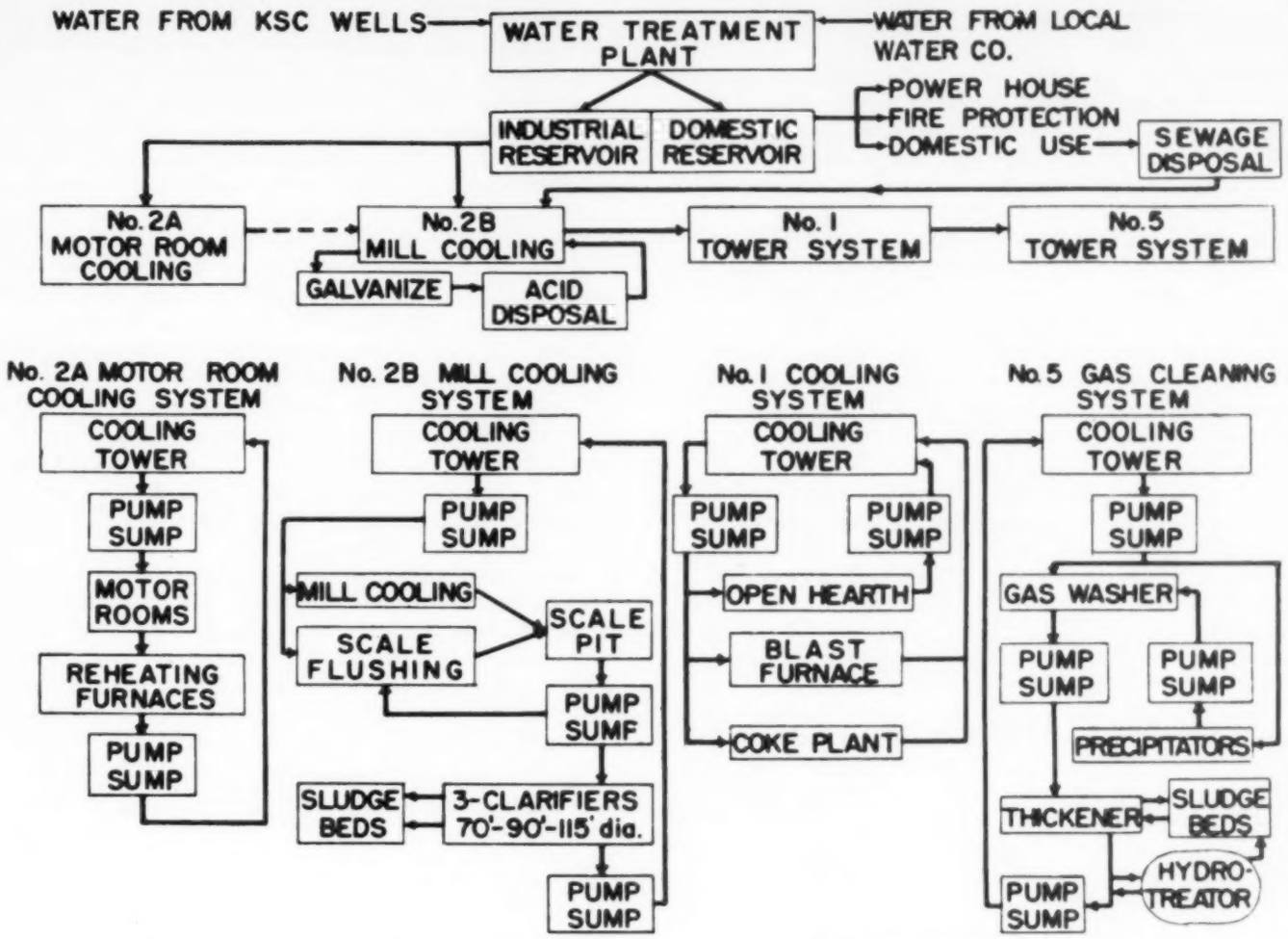


Figure 4 — Flow diagram at Fontana plant makes maximum use of available water through recirculation.

where

- v is settling (or rising) rate
- r is the effective radius of particle
- S_s is density of particle
- S_f is density of fluid
- n is absolute viscosity of the fluid

This formula assumes perfect spherical and discrete particles, completely quiescent liquid, no electrostatic potentials, as well as smooth and effective removal of separated substances comprised in the flow. None of these conditions can be completely attained in full-sized installations and under practical conditions of operation.

Most departures from the ideal conditions, such as non-quiescent conditions, irregular shape of particles, electrostatic conditions, etc., slow down the settling (or the rising) velocity of materials, and therefore prolong the time required for separation. However, there are several offsetting effects, the principal being that originally discrete particles can agglomerate in the settling tank, thus greatly increasing their vertical velocities. Other favorable factors are the comparative high temperature and therefore low viscosity of the water and the relative denseness of such substances as flue dust and mill scale.

In designing a gravity separator process for a specific waste, the actual conditions under which the operation is to take place must be carefully studied. The first step in gravity separation design is to determine for any given density of material and size of particles that is to be separated (i.e., intercepted and removed), the so-called overflow rate, which is the discharge into a tank divided by its net surface area and which is usually expressed in gallons per minute per square foot. The overflow rate may also be expressed in (vertical) feet per minute and can be used in the Stokes formula to determine the theoretical size of discrete particles that will be removed under ideal gravity separation conditions, as described above. In practice, as has been noted, such computations have to be modified by the actual characteristics of the various particles. Furthermore, the design overflow rate must also be reduced to allow for tank displacement efficiencies, which are always considerably less than 100 per cent, so as to take into account the turbulent and non-uniform velocities at the entrance and at the exit of the tank, instability of flow, faulty proportions of the tank and other imperfect hydraulic factors.

With certain types of wastes, such as flue dust, the particles exhibit a tendency to agglomerate if given adequate opportunity. The building of a larger particle from two or more discrete particles of dust results in increased vertical velocities. Agglomeration may be hastened or created by applying chemical coagulating agents. Only by testing the particular waste with the various agents, both on a laboratory and pilot plant

scale, can the rates of settling of agglomerated material be determined.

In flotation processes, the rate of rise of particles less dense than water may be increased by the proper application of air, or other gases, into the treatment unit. This may be preceded by coagulation to form a floc. This method is particularly applicable to soluble oils and emulsions.

In designing gravity separators, it is first necessary to know the present and also the probable future effluent quality criteria. One must have adequate data on the volume and characteristics of the waste. This includes the physical properties and behavior of the waste substances, the varying rates at which they are produced, and the volume and temperature of the water with which they are discharged at any time.

Field surveys are required, which may comprise measuring the actual supply of water introduced into each part of the system and gaging the flows into the sewers. This should precede the selection of equipment and detailed designs. Otherwise, the frequent practice of bypassing, or diverting, part of the wastes from the treatment units may unintentionally give a false account of the conditions to be dealt with, including the performance of any existing equipment.

One must carefully work out just how the settled, or floated, wastes are to be removed from the tank and subsequently handled and disposed. Quite often, this phase represents the principal difficulty in designing installations that would not be too costly.

The relative savings in cost of separator tanks through the use of various chemicals should be estimated on the basis of systematic laboratory tests. In many cases, the best solution might be to provide equipment that is adequate for assuring the necessary clarification of the present wastes discharges without the use of chemicals. Then, any increases in wastes loads, or future stricter quality criteria, could be met by additional chemical treatment without major enlargement of the separators themselves at a time when space may be even more difficult to find.

Only after all these factors have been determined is it possible to make a final layout of the installation required, select the equipment and proceed with detailed designs.

RECIRCULATION

One of the most effective ways to meet anti-pollution regulations is to continue reusing water until it disappears. This is actually being accomplished at the Fontana Steel Plant as described by H. E. Riegel "Industries' Water Problems and Their Solution," November 1957, *Iron and Steel Engineer*. It is true that in this particular instance it was lack of supply that determined this unusual procedure.

At this plant, water is secured from a limited underground source and because of short supply, it must be husbanded carefully. This is done by passing the water successively through a number of systems in an order that corresponds to decreasing quality requirements. The final step is to use the waste to cool the slag and to spray raw materials for dust control. The result is no final effluent. Here we have a case where the supply of water and the treatment of wastes is a single co-ordinated operation.

The above, of course, is an extreme case. Reuse, or recirculation, of waste waters is not uncommon, but it is rare to find no final effluent. Recirculation will generally change the character of the waste so that in final form the waste will be more concentrated. This is important. Anti-pollution standards are usually stated in terms of a permissible proportion of particular elements or groups of contaminants in the final effluent. In other words, it is not the total quantity of objectionable substances that the authorities usually seek to limit, but rather it is the excessive concentration in the discharge that is considered objectionable.

Incidentally, it seems strange and inconsistent, in light of the above, that certain regulations prohibit diluting a concentrated waste with other wastes not containing the particular contaminant. A review of this requirement seems in order if realistic disposal methods are to be found for such difficult substances as phenols.

As already stated, reuse of a waste water would seem desirable from the treatment point of view. It will decrease the volume of final effluent that may have to be conditioned. Presumably, this should reduce the cost of treatment, but that is not always the case.

In one instance, where the use of water by a hot strip mill is particularly high, scale removal is secured with relatively small-sized pits. Nevertheless, the effluent due to the high rate of discharge has less than the permissible limit of concentration of suspended matter. However, an investigation showed that if the effluent rate was reduced by fifty per cent, as would happen if recirculation was employed, more elaborate treatment facilities would be required. The decreased rate of flow would double the concentration of the finer fractions of scale, and these fine particles cannot be intercepted by conventional small scale pits. Recirculation problems of the same type may be found with other waste substances such as oils and phenols.

Another case where intensive recirculation increases rather than reduces the waste disposal problem is a large steam power plant which has a limited water supply. Recirculation is used for condenser cooling. The final effluent, including boiler feed blowdowns, has such a concentration of contaminants that the flow cannot be treated economically. It has to be transported 82 miles for discharge into the sea.

On the other hand, recirculation can frequently reduce the cost of waste treatment. The waste discharge from a finishing mill generally contains a high percentage of soluble oils for which a fairly complicated chemical and flotation treatment is usually required. A large once-through flow would therefore need very expensive treatment installations. Recirculation of the wastes with occasional blowdown can reduce the quantity of the final effluent that must be conditioned say 95 per cent. The resulting savings in treatment cost are obvious.

One should therefore consider each case of recirculation as a distinct problem which must be analyzed in technical and economic terms and solved on an individual basis.

FLUE DUST

Up to now, the treatment of gas washer effluents at most steel plants has been directed primarily at provid-

ing the simplest facilities for intercepting the bulk of flue dust produced; and where sinter plants were available, the economic recovery of such settled waste material. Existing wet flue dust treatment installations in most cases may be adequate for these limited operations. However, in view of the stricter effluent quality criteria now being introduced, or to be anticipated, this section is aimed at the effect of such anti-pollution regulations on the basic layout and design of flue dust treatment projects and the additional facilities that may be required.

Currently, a number of sintering plants are being built for the utilization of lower grade ores, and improving blast furnace performance. These new and expensive facilities make it possible to obtain some economic return for improved wet flue dust interception. One must keep in mind that the type and design of gas washer effluent treatment plant that is best adapted for most economic flue dust recovery is usually simpler than the layout and facilities that are necessary to obtain a legally acceptable effluent at all times. In other words, a plant where occasional by-passing and discharge of dirty gas washer effluent is justifiable on economic grounds, would not be adequate in terms of anti-pollution requirements. In fact, these demands are generally so high that if a plant can meet them, it automatically intercepts and makes available all the wet flue dust that is worth recovering.

Quantities and characteristics—The amount and composition of blast furnace flue dust is controlled by the following principal factors:

a. The composition and size of the charge into the furnace (particularly the characteristics of the ore).
b. The size and design of the furnace.
c. Methods of operation (charging practice, the amount of air supplied and top pressure used).
d. Type, size and method of operation of dry dust catchers and gas washers used.

Based on findings and surveys of several blast furnace plants, representative figures on quantities and concentrations of wet flue dust are given in Table I.

TABLE I
Flue Dust Output

	Range	Representative average
Total dust (lb per ton iron)	50-800	250
Wet dust (lb per ton iron)	50-200	90
Wash water (gal per ton iron)	1000-6000	3000-4000
Solids concentration in wash water (ppm)	1000-10,000	2000-3000

The wide variation of the unit figures is to be noted. Experience at several plants confirmed that the average content of flue dust in gas washer effluents ranges from 1000 to 10,000 ppm (0.1 to 1 per cent). After a "slip" in the furnace, or when a gas washer is being agitated or cleaned, the momentary concentration can be as high as 2 to 3 per cent.

Based on a total U. S. production of 80,000,000 tons of pig iron per annum, the total amount of *wet* flue dust produced is almost 4,000,000 tons. This flue dust consists primarily of iron oxides. The particles have a specific gravity of between 3.0 and 4.0 (average—3.6). Iron content (Fe) is 40 to 45 per cent; oxygen 20 to 25 per cent; silica 10 to 14 per cent; carbon 4 to 14 per cent and miscellaneous 10 per cent.

In order to insure final effluents of satisfactory quality, the amount of concentration of the finer fractions (less than No. 200 mesh) must be considered. The difficulty is that the composition of wet flue dust varies widely.

The range of particle size in the flue dust leaving gas washers is very large. A representative analyses may be as given in Table II.

TABLE II
Wet Flue Dust Characteristics

Size of Mesh	Per cent
+100	3 to 10
100 to 200	7 to 15
−200	70 to 90

At one steel plant, tests indicated that 70 per cent of the total (wet) flue dust from the gas washers was No. 325 mesh (44 microns) and 50 per cent was below 10 microns. Particles from precipitators and disintegrators can be even finer than that.

Data on typical gas washer discharges, settling rates and the density of sludge of various consistencies, etc., are shown on Figure 5. These represent observations made at four different plants.

Design considerations—There is generally no difficulty in intercepting and recovering most, i.e., 90 per cent of the wet flue dust load in gas washer effluents. This dust, (larger than 20 microns) is coarse enough to settle out by gravity; with the overflow rates and within the detention times normally provided by thickeners.

The problem of dealing with the finer fractions is illustrated by Figure 5. It will be noted that for a total detention time of one hour (under laboratory or ideal quiescent conditions) during the first fifteen minutes, 75 per cent of the dust settles out, whereas during the last fifteen minutes, only 4 to 5 per cent is removed.

In most cases, plain sedimentation with adequate size clarifiers results in effluents that meet most of the current anti-pollution standards. In some cases, where ores are particularly fine, or where the regulations are very strict and include control of color, it may not be practicable to intercept without coagulants, the finest particles, which represent 2 to 3 per cent by weight of the total load, and can amount to 5 to 10 grains per gallon (85 to 170 ppm) in the effluent. The different ways in which this can be done are discussed under the heading of "Improved Methods" in this section.

Present methods—The discharges from gas washers are treated by gravity separation. This is accomplished ordinarily by thickeners, equipped with revolving rakes for sludge disposal. These circular tanks operate on the upward vertical flow principle.

There are several manufacturers of satisfactory equipment. Because each of these tanks operates in a slightly different way, the exact proportions of the tank and detailed design of the mechanism are determined by the supplier of the equipment.

Provided the thickeners are of sound design and not

badly undersized, it is relatively easy to obtain an effluent with a flue dust load of slightly less than 10 grains per gal. In most areas, such interception will meet anti-pollution requirements. In a few instances, special conditions, such as quality requirements for recirculation, may require two-step clarification (two thickeners in series), the second step involving the use of coagulants.

Most flue thickeners at present operate effectively. However, difficulties do arise when, because of expansion in production, both the discharge from the gas washers and the flue dust load increase. Rarely is any space available close by for adding new thickeners, or enlarging the existing ones. If the thickeners are to be located at some distance from the furnaces, careful planning is required to convey the flows with heavy loads of suspended matter from the washers to such distant treatment installations, without deposition of the flue dust in the sewer system.

The effective formation and removal of sludge of proper consistency from the thickeners is of utmost importance. The conveyance of sludge to the filters and into the sinter plant, involves operating and maintenance problems. Supervision and the servicing of pumps, sludge lines and filters are required to assure uninterrupted treatment. The frequency of breakdowns in plants where the aim is only to reclaim most of the flue dust is not generally known, because of the ease with which flue dust recovery units can be by-passed and the effluents directed into the sewers without any treatment at all. But as anti-pollution regulations are tightened up, such practices will not be permitted, and this will require both standby capacity and a more continuous efficient operation of all the installations involved.

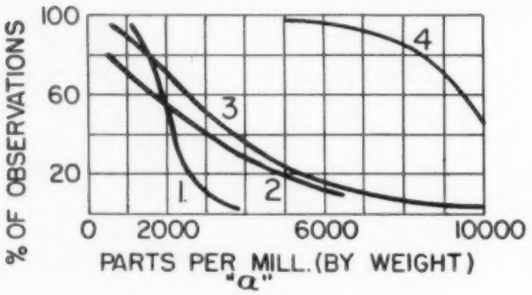
In this respect, flue dust interception, handling and recovery facilities in most steel plants are frequently inadequate. In practically no steel mill are there standby units, or a reserve in capacity that will permit proper handling of the discharge from all the gas washers should one of the thickeners, sludge pumps or pipelines temporarily cease to function.

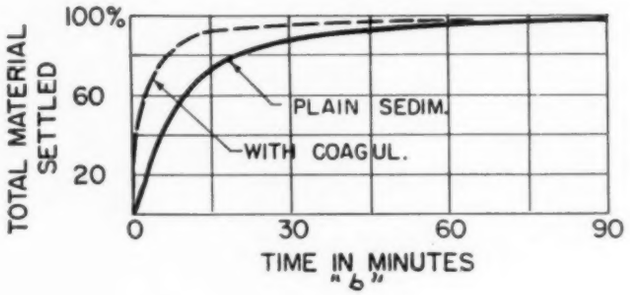
It is generally anticipated that with the increase in the use of beneficiated ores over the years, the amount of flue dust that enters gas washers will be considerably reduced. On the other hand, the concurrent rise in the production rate of the furnaces and higher blowing rates, will tend to offset a radical change in that respect.

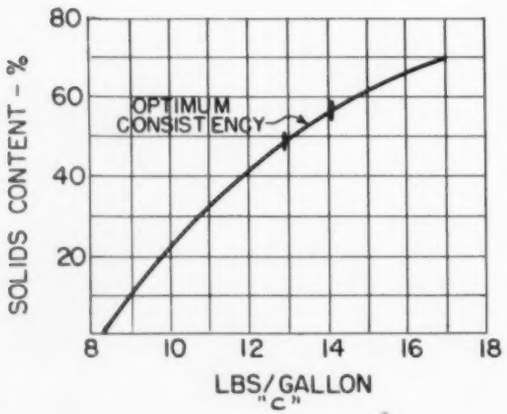
Improved methods—Thickeners: The separation of flue dust particles which have a high specific gravity, usually occurs under favorable conditions. Except when there are detrimental substances in the water supply that prevent the formation of a thick enough sludge, there are no adverse chemical reactions, and the settling of the particles is accelerated by the lower viscosity of the water, due to its higher temperature (85 to 120 F).

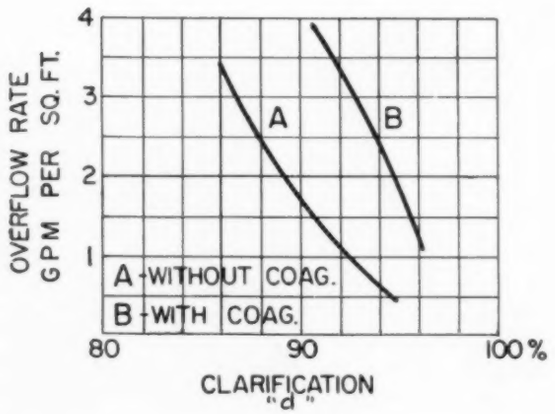
The basic technique of interception of flue dust by thickeners was worked out some time ago. Nevertheless, in recent years, there have been some modifications in thickener design. The circular tank and the method of collecting the sludge in a central sump by slowly rotating arms has not changed, but double tray

Figure 5 — Curves show wet flue dust characteristics. In "a," curves show flue dust concentration in gas washer effluents at four different steel plants; in "b," curves show rate of sedimentation of flue dust; in "c," curve gives sludge density; in "d," curves give effect of coagulating agent.









tanks are being eliminated. Tank depths are being increased, overflow weirs have been modified, and the inlet (feed) well is adapted to give a swirling motion to the flow entering the tank, which accelerates agglomerating actions.

For any given discharge and concentration of flue dust, sound criteria are available for achieving the degree of interception desired. Obtaining an effluent containing less than 10 grains per gal may, for example, require an overflow rate of 1.25 to 3.0 gpm per sq ft, and/or detention times of 40 to 80 minutes.

After the required size of the tanks is determined, it may be found that there is physically no space close to the furnaces for such thickeners. Since locating clarifying equipment far from the gas washers is not an easy task and may be quite expensive, one may have to resort to other methods. Either special venturi type gas washers, which reduce the discharges, or new synthetic coagulants, which accelerate the process of clarification, may be used. In many cases this still leaves a problem of how to handle the sludge produced within a congested area. Generally speaking, it would seem advisable to provide, where possible, thickeners of adequate capacity for the present requirements, and to reserve the above mentioned special measures for the future, if and when still cleaner effluents may be required.

Venturi gas washers: In a number of plants, conventional gas washers are being successfully replaced with new venturi type installations. These usually include an aftercooler. Although this means that there may be only a relative reduction in water demand, there are other advantages.

Due to the special design of the tower, the venturi throat and the use of higher pressure, directed sprays, wash water requirements are reduced by 60 to 80 per cent. A cleaner gas is produced and the furnace can operate at higher top pressures. Obviously, the handling and adequate treatment of say 600 to 1000 gpm of dirty discharge from a venturi type washer is easier than the 1500 to 3500 gpm from a conventional washer. Furthermore, although the higher concentration of flue dust, especially of the finer fractions, requires a somewhat lower overflow rate and longer detention periods, the size of the thickeners and dirty water sewers can be greatly reduced.

If a separate cooling tower is used, care must be taken that its discharge does not contain a concentration of fine dust in excess of the allowable limit. If treatment of the discharge from the aftercooler is also required, one of the principal advantages of the venturi type installations would be lost. A very conservative design of the gas washer unit will reduce to an acceptable amount, the fine dust reaching the aftercooler.

Cascading: At some plants, thickeners are operated according to the "cascading" principle. This consists of placing the thickeners in series. The sludge from the first thickener serving the first gas washer is discharged into the influent of the second thickener serving the second gas washer, and so on.

The increasingly heavier load of suspended matter (flue dust) in the influent of each successive thickener does not raise the concentration of residual flue dust in the clarified effluent from each of the thickeners. Actually, it has been observed that the clarification process may be benefited by the agglomerating effect of the added sludge. Another advantage is that all the sludge is accumulated in the final unit from where it can conveniently be pumped to the filter house.

There are, however, some minor adverse factors. In the first place, provisions must be made to bypass any thickener that may go out of operation in order to maintain continuous treatment of the effluent from all gas washers. Also, though the final amount of flue dust intercepted and recovered may be the same in both cases, the sludge must be handled repeatedly, which means more extensive pump and sludge line operations and greater maintenance problems.

Coagulating agents: The use of coagulating agents will be briefly touched upon. There is no question that some of the new chemicals, properly applied, can greatly speed up the deposition of the bulk of the flue dust load. Interception of the very finest fractions, however, is not quite so spectacular. For example, if the effluent must have less than five grains per gallon of suspended matter, the reduction in the size of the thickeners due to the use of chemicals will not be very great. To comply with such extreme standards, a fairly low overflow rate (or long detention time) is required whether chemicals are used or not. In most cases, and especially where a concentration of ten grains per gallon, in the effluent is permissible, the relative advantage of reducing the size of the thickener through the use of coagulating agents must be compared to the cost of providing and installing chemical storage and feed equipment and of the chemicals consumed. The use of chemicals also increases operating problems.

Whether or not one should use these coagulating agents in any given case can only be decided after a study of all the factors involved. Generally speaking, it is believed preferable to install, at the start, thickeners of adequate capacity to meet present loads and effluent standards. This makes it possible to resort to the use of chemicals at some future date, when the wastes loads may be larger, or the effluent criteria made stricter. At such a time, advantage might be taken of a drop in the cost of these special chemicals, which is anticipated once they become a competitive product.

Layout design considerations: Until recently, the usual improved layout has been to provide a separate thickener for each blast furnace. See Figure 6. Looking ahead, there may be two drawbacks to this arrangement. First is the problem of continuous operation—if a thickener is not operative, the dirty discharge from the gas washer will be bypassed directly into the effluent sewer, which under future anti-pollution regulations may not be permissible. Second there is a problem of limited space, for such thickeners occupy considerable areas close to the furnace. As the productive capacity of the furnaces is increased, any available space will become particularly valuable for enlarged or auxiliary equipment, or for storage of materials for the more rapid relining, or reconditioning of the furnace. Mill operators will undoubtedly be reluctant to use it for purifying effluents.

In view of the above mentioned conditions, and apart from the design of the thickener proper, the following objectives of a flue dust treatment improvement project should be satisfied. A layout that takes into consideration these points is shown on Figure 7.

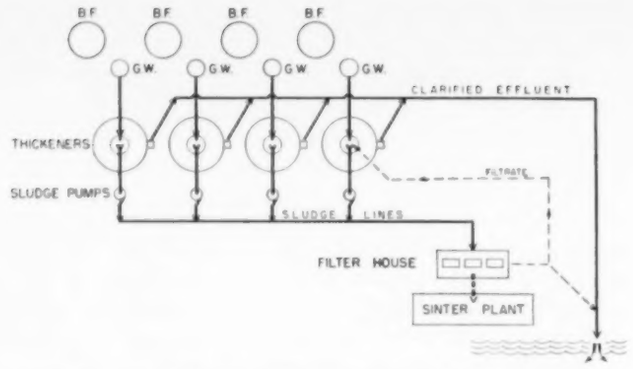
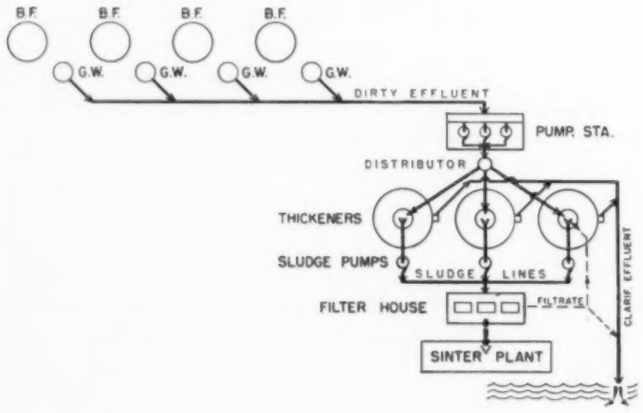


Figure 6 — In this layout for handling flue dust, a separate thickener is provided for each blast furnace.

a. The discharges from gas washer should be carried to the thickeners without deposition of flue dust in the sewers.
b. Gas washers and thickeners should be interconnected in such a manner that interruption in the operation of a thickener does not result in a dirty discharge into the stream.
c. Sludge from the thickeners should be conveyed to the filter house with a minimum of operating and maintenance difficulties.
d. Sludge of optimum density and consistency should be fed to the vacuum filters to insure their uninterrupted operation.
e. The filter cake should have a low moisture content and be handled and utilized effectively.
f. Satisfactory equipment and layout should be selected to permit continuous operation of all gas washers, as well as to provide for a higher degree of treatment, should it be required in the future.

Because of the congested conditions at existing steel plants, the most difficult aspect of such programs is the layout of the flue dust collection system. It is also not easy to find space for the tanks and for subsequent dust handling and recovery equipment, such as sludge pumps, pipelines, vacuum filters, filter cake transport machinery, etc. All these installations must operate with a minimum of supervision and maintenance. The desired objectives can be achieved only after a careful field survey and study of alternate solutions permits the working out of a comprehensive plan. Thus, it is seen that the selection and design of the thickeners represents only one phase of the total engineering task that must be accomplished.

Figure 7 — This layout for flue dust treatment has certain advantages over that given in Figure 6.



MILL SCALE AND OILS

General—In a typical integrated steel plant, mill scale represents one of the three most important waterborne waste products in terms of quantity (total weight), in reclaim value of the intercepted materials, and finally in the cost of the necessary treatment facilities. The only other waste substances of comparable importance are flue dust and waste pickle liquor.

This discussion of the treatment of mill scale and (free) oils and greases is primarily directed to effluent from primary scale pits with which almost all of the existing mills are equipped. These are capable of intercepting the bulk of the scale, but with regard to treatment, they have the following limitations. Their capacity is small, the hydraulic design rudimentary, the method of removal of scale by dredging with overhead bucket disturbs sedimentation and there are no provisions for intercepting and disposing of oils. As a consequence, the effluent from pits of this type will not continuously meet typical quality standards, such as where suspended matter (at any time) is limited to less than 170 ppm and oils to less than 30 or 50 ppm.

In general, scale particles, due to their high specific gravity, settle out very rapidly. Because of this, despite the inadequacies of most pits as described above, the effluent from same may, most of the time, conform with quality regulations such as cited above.

What makes it necessary to provide additional treatment facilities are usually these four factors:

a. The existing scale pits are not cleaned out frequently enough and therefore do not effect the minimum required interception of scale.
b. The effluent from any scarfers that are used contain fine scale that cannot be settled out sufficiently in conventional pits.
c. There is carry-over into the discharge sewer of excessive amounts of scale from the pits, during the violent disturbance of the contents, when scale is being dredged out.
d. No provision is, or can be, easily introduced for the interception of occasional excessive concentrations of (free) oils and greases.

Quantities and characteristics—All hot rolling mills (ingot, slabbing, blooming, structural, plate, bar and strip) produce mill scale. The scale, by weight, is usually equivalent to 1½ to 3½ per cent of the steel production. Considering that a few of the latest continuous hot strip, and also slabbing mills, have a monthly capacity of 200,000 tons or more, the amount of scale to be dealt with may be over 5000 tons per month for one mill.

Mill scale consists mostly of iron oxides (FeO, Fe_2O_3 and Fe_3O_4). The specific gravity varies between 4.5 and 5.5. The iron content is high and has a definite economic value, so that any scale that is recovered is generally fed to the open hearth furnaces.

The amount, concentration and the size gradation of scale in the discharge to be treated at any time may vary widely. These will depend on the type of mill, the product turned out, the output, the volume of water used, and whether or not some of the scale is removed in dry form. This wide range can be illustrated by ob-

TABLE III

Average Concentration of Suspended Solids in Discharge

	Flow, gpm	Amount passing screen mesh, ppm			
		Total	No. 100	No. 200	No. 325
Slabbing mill	7,000	5,000	600	400	300
Hot strip mill	25,000*	1,000	350	200	125
Billet mill	2,500	2,500	1,000	600	400
Bar mill	5,000	1,000	400	100	75
Hot scarfer	2,000	5,000	1,200	800	600

* Without Recirculation.

servations made at an integrated steel mill shown on Table III.

The mills use more oils and greases than are accounted for in the effluents from the pits. The reason is that part of the oil is adsorbed by mill scale particles and is removed with them. Normally, the concentrations are very low, i.e., in the order of 5 to 15 ppm. The need for intercepting oils arises following washdowns of rolls, purgings from tanks or sumps and from occasional spillages or dumpings of oil. During short periods, the effluent from pits contain slugs of oil which enter the sewers. Such excess concentrations of oil are easily detected at the outfalls.

Design considerations—There is usually no difficulty in intercepting scale particles down to 200 mesh size (149 microns). Such water-borne coarse scale easily settles out in ordinary scale pits having only three to six minutes detention time. This amount of treatment is usually available in the older mills. However, quite often as stated above, the pits are undersized, their "displacement" efficiency is poor, and they are not cleaned out systematically, with the result that the suspended load in the effluent is frequently too high. During the periodic dredging operations for the removal of scale, the process of gravity separation is interfered with, the flow is disturbed, and excessive amounts of scale are carried away in the discharge. Such losses in some of the larger mills may amount to as much as 1000 tons of scale per month. If the mill continues in operation, with a large part or all of the pit full of scale, even greater losses have been observed.

From Table III it will be observed that from 10 to 20 per cent of the total amount of scale may be smaller than No. 200 mesh, and further that two-thirds of this may be smaller than No. 325 mesh (44 microns). Even under ideal hydraulic conditions, the finer than No. 325 mesh fraction requires approximately three times as large a tank to achieve the same degree of interception as for the No. 200 mesh material.

The settling rate curve in Figure 8 illustrates the approximate requirements for scale pits which must intercept the finer than No. 200 mesh mill scale. The effluent from scarfers may have to be segregated and chemically coagulated. Finally, to deal with excess concentrations of oil, baffles, skimmers, oil collecting and disposal equipment must be provided.

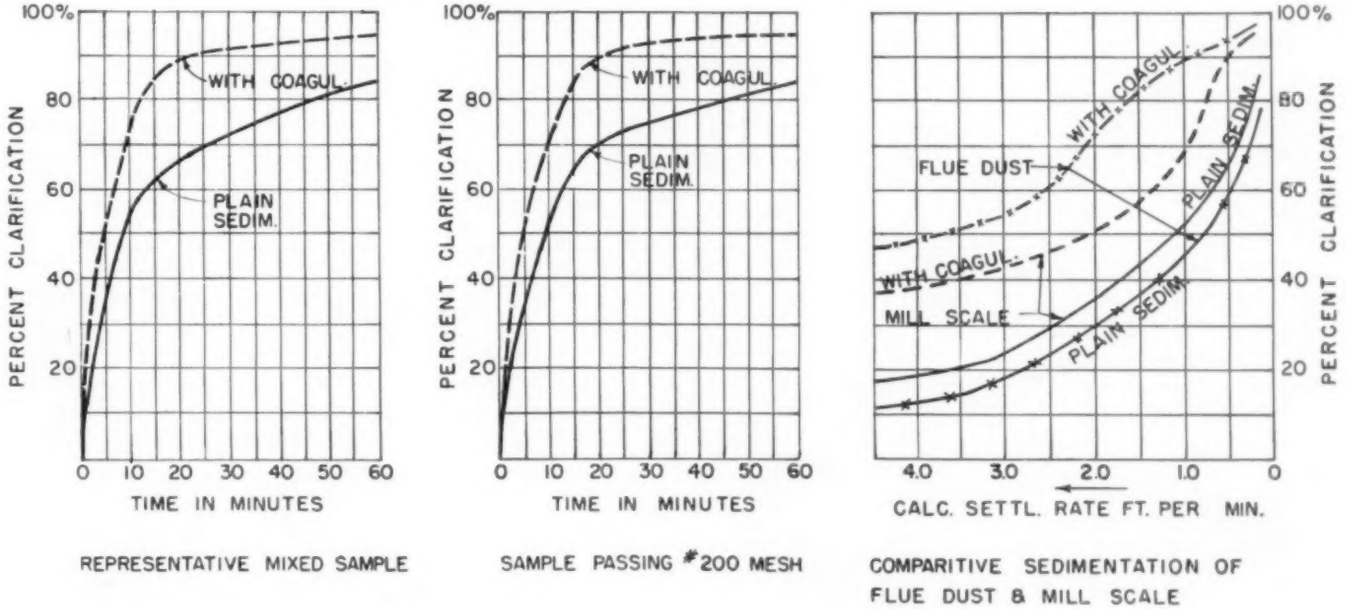
Mill scale treatment facilities must be located close to the mills, otherwise long, deep and expensive flumes and sewers will have to be installed. Finding suitable sites for secondary, or the combined, treatment units can often be the most difficult and costly phase of the project.

Present Methods—Existing scale pits are usually open, deep, rectangular pits, with armored sides where the discharge from the mill is momentarily retarded and the deposited scale is periodically removed by dredging.

The rudimentary design and inadequate size of the pits can be explained by the ruggedness the pits must have to resist the banging of the dredging bucket and the very high cost of construction 25 to 45 ft below grade. These depths are imposed by the steep slopes of flumes and sewers required to maintain high enough velocities in same to avoid the deposition of scale.

Such scale pits, despite their obvious limitations, are capable of intercepting 75 to 90 per cent of all the scale produced. However, one cannot justifiably classify such installations as treatment units. Their object is to prevent the larger particles of scale entering the sewer system, where they would deposit and cause trouble and

Figure 8 — Curves give clarification and sedimentation characteristics of various types of mill scale.



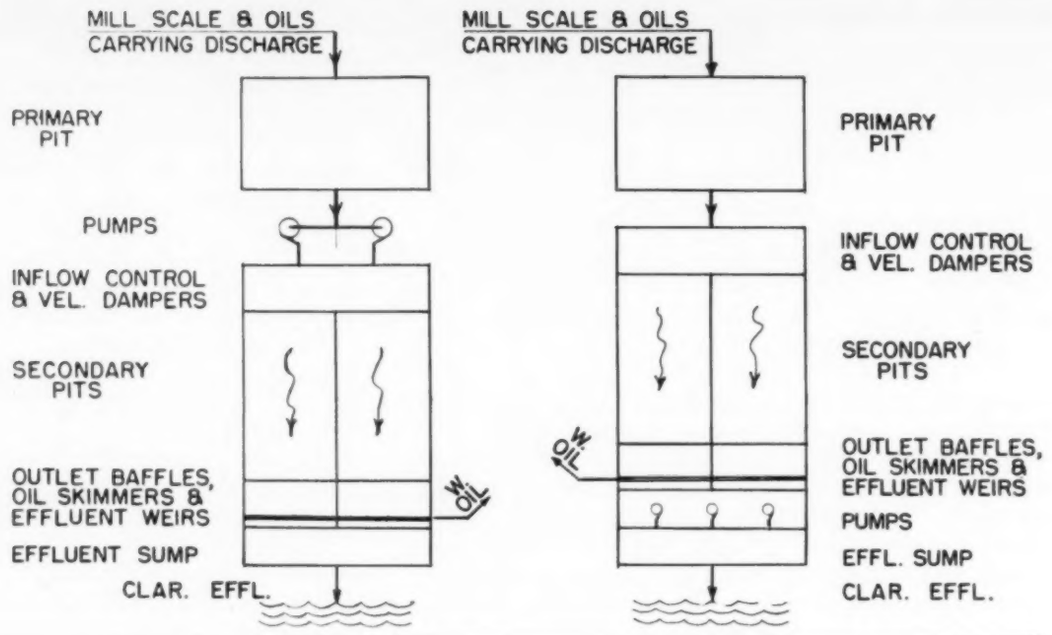


Figure 9 — Schematic shows dual scale pits for mill scale and oil treatment.

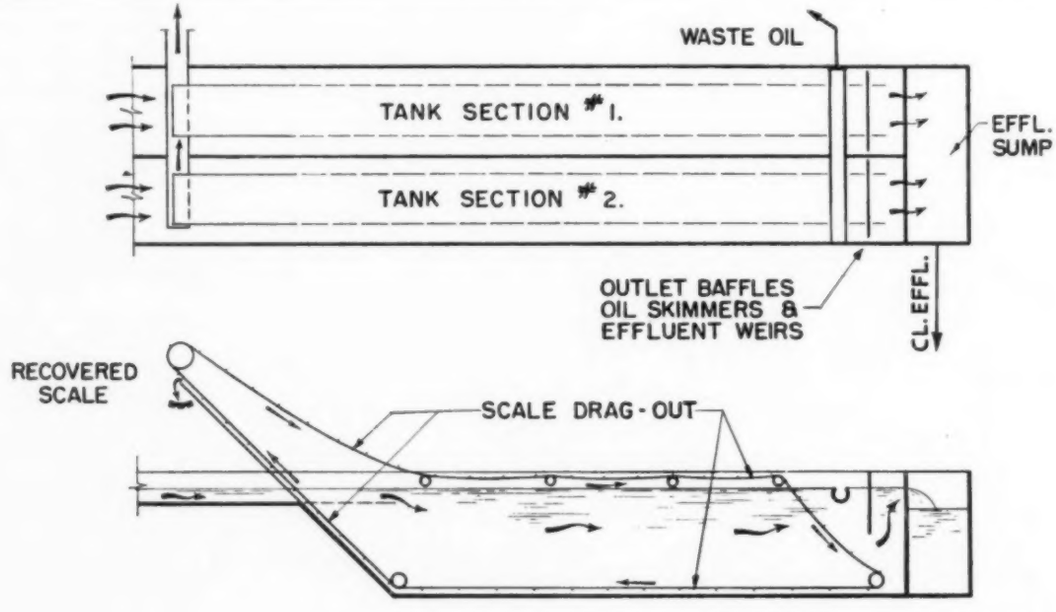
of course to recover the bulk of the scale for reuse in the furnaces. If properly cleaned, they can fulfill both functions. The very few new mill scale handling installations that can insure, continuously, an effluent of acceptable quality are discussed in the next section.

Improved methods—Dry handling of scale: The technique of collecting and utilizing of dry scale mechanically (i.e., without the use of water) has made some progress. Several new mills are installing such systems. The aim is to intercept the major portion of the scale, including all the large pieces, in dry and unadulterated form, for convenient handling and recovery. Usually provisions are made to do this only at several of the initial (roughing) stands. Water must still be used for cooling and descaling at the subsequent finishing stands and the runout sections of the mill. Consequently, the mill scale bearing effluents, while reduced in volume, are not eliminated and scale pits are required.

The problem of treatment for quality effluent control is not greatly changed. As noted previously, it is the amount of scale particles passing No. 200 mesh, and their concentration in the flows dealt with, that determine the type and size of the treatment facilities required. Dry handling lightens the overall treatment task only slightly, that is, to the extent that the heavy scale, including all the larger pieces, are intercepted before they reach the scale pits. Also the volume of water to be dealt with is reduced by the proportion that would have been used at the initial stands.

Modification of existing scale pits: The design of the usual type scale pit can be considerably improved by taking into consideration the principles of gravity separation, as described earlier in this review. Since most existing steel plants are already equipped with costly, deep straight flow-through rectangular armored pits from which scale is removed by dredging, the question arises what to do with them. In most cases, they should be retained. Even though they are inefficient in removing the finer scale fractions, if properly and systematically cleaned, they can handle most of the scale produced. Certain improvements can be introduced. Dampening the entrance velocities and improving

Figure 10 — Schematic shows pit design for mechanical removal of mill scale and separation of oil.



water exit conditions may be feasible.

One complication that arises is that, for additional treatment, the effluent from scale pits must nearly always be pumped. Fortunately, special pumping equipment has been developed to handle scale bearing flows, provided the concentration of particles over No. 200 mesh in size is not excessive. Installing pumps might require radical reconstructing of the old pits. Rarely will modifications of existing scale pits be sufficient to effect adequate treatment by themselves. The object is to reduce the task and cost of the secondary treatment installations that will, in most cases, be required.

Two step treatment: Assuming the best solution is to leave the existing scale pits as they are, one usually will have to install new secondary scale pits. These essentially consist of dual, gravity separation tanks, with or without continuous (mechanical) removal of scale. Pumping facilities are usually so incorporated as to avoid very deep and expensive construction. See Figures 9 and 10.

Space permits only a summary description of such installations. The tanks must be sized for overflow rates of about 2 to 5 gpm per sq ft, with retention times ranging between 15 and 40 min. The velocity of entry into the tank must be effectively dampened. The water level into the tanks must be closely controlled. At the outlet, a baffle and oil skimmer must be provided to intercept any oil. Oil pumps, elutriation and storage tanks are needed to concentrate and help dispose of the oil. Mechanical removal of scale by chain dragouts has been perfected. In all cases, dual tanks should be provided as any equipment of this type is liable to breakdowns. In such an eventuality, in order not to interrupt the operation of the mill, the entire flow would be directed through the other section.

Coagulation with chemicals: As in the case of flue dust, coagulating agents can greatly speed up gravity separation. The same economic arguments apply. The main drawback of coagulation is the extra equipment controls and supervision that are required. Where scarfers are used, it may be advisable to segregate the discharge from same, and provide a small packaged type coagulation plant for the prior treatment of just this particular flow. A few mill scale treatment plants use coagulation for the entire discharge, but that is done to insure a superior quality waste water for reuse within the mill, and may not be necessary to satisfy pollution control regulations.

Combined treatment: For new steel plants, and also for existing plants, where the old scale pits cannot be adapted, it may be simpler and cheaper to build entirely new, improved scale treatment facilities to do the entire job.

Such combined treatment facilities will essentially consist of a primary pit, pumps, secondary dual tanks and scale and oil removal equipment. Each treatment installation of this type would have to be of special design to fit the particular conditions at the mill.

Complete treatment: In a few cases, secondary treatment has comprised coagulation and clarification, and the vacuum filtration of the mill scale sludge. The purpose is to obtain water of high quality for re-use in the mill. A notable example of intensive treatment of mill scale effluents is to be found at the Armco's Middletown plant. A full description of this operation was recently given by Grant Pettit in the September 1957 *Iron and Steel Engineer*, entitled "Treatment and Reuse of Mill Scale Wastes to Conserve Water and Abate Pollution."

SOLUBLE OILS

General—Soluble and emulsified oil wastes are present in the discharges into the sewers from cold finishing mills, electrolytic tinning operations and roll grinding and machine shops. Minor amounts may be contributed by fog exhaust and other auxiliary processes. In most cases, the effluents also contain lubricating oils dripping from machines.

These various oil substances can be broadly classified as those soluble in water and those insoluble in water, the latter representing the smaller portion.

Because of restrictions on oil content in effluents, that specify they should not exceed 50 ppm (or in some cases even less), it is advisable to try to reduce the discharges and spillages of oil into all outfall sewers. Good housekeeping is necessary and the oily wastes (especially if these are of the soluble variety) should be segregated near their source so as to recycle them if at all possible. For if large oil carrying discharges are allowed to join the trunk sewers of the mill, an almost insuperable terminal treatment problem will result.

The discussion in this section is directed at the treatment of soluble oils and emulsions. Any free oils that are not intercepted by plain skimming undergo the same treatment as emulsions and soluble oils and are removed with them.

Quantities, characteristics, and design considerations—The rates of discharge and characteristics of the soluble oil wastes vary widely. It is estimated that some 25,000 tons per annum of soluble oils are used by the industry. A large part of this total, possibly 15,000 tons annually, is discharged into the sewers and in most cases it will be necessary to treat it.

The concentration of soluble oils in the effluents from the finishing mills and roll grinding and machine shops depends primarily on whether the effluent results from a once-through or from a recirculation operation. Where a very large volume of water is used on a once-through basis, and where oil conservation practices are employed the concentrations of soluble oils in the effluent may be such that no special treatment for their removal is required to meet moderate anti-pollution regulations.

However, usually the once-through effluent of 2000 to 5000 gpm from say a cold reduction mill has a soluble oil content of approximately 100 to 200 ppm. If such a concentration is not permissible, the interception and disposal of soluble oils from such a large flow would be prohibitively difficult and costly. In modern mills, recycling of water from stands where coolant oils are applied is practiced. This oily effluent is segregated from the discharge from stands where oil is not used, and is recirculated through storage tanks where the oily sludge and scale settles out. The clarified oil carrying water is pumped back to the oil using stands. The storage tanks are periodically purged. The rate of discharge of this "blowdown" from the tanks, which must be treated, is determined by operating considerations, i.e., the frequency and length of time required to empty the tanks. Representative rates would be 50 to 200 gpm for a few hours, once or twice a week, with a solu-

ble oils content of anywhere from 2 to 10 per cent (20,000 to 100,000 ppm).

The emulsion carrying discharges produced by roll grinding and machine shops are very much smaller, but can be handled in a similar manner as an additional load.

The chemical characteristics of oil bearing discharges vary. The pH may be from 6 to as high as 10.5, depending on whether the alkaline cleaning fluids are included or combined with soluble oils upon discharge.

Soluble oils are normally quite dark in color and cause the water to be opaque. Free oils rise to the surface, causing an unsightly slick on the waters into which they are discharged. This is why in spite of the fact that normal plant operations tend to reduce oil wastes, antipollution standards have been set which require further removal of oils from effluents.

The interception of soluble oils and of emulsions cannot be done by simple gravity separation, as in the case of free oils. Because of the size of discharges involved, it is not practicable to heat the effluents sufficient to break the emulsions. Only certain chemical methods, all unfortunately involving the production of large volumes of sludge, have been found applicable.

Present methods—As previously mentioned, the current practice is to break the soluble oil emulsions by means of chemical agents, some of which are ferrous sulphate, aluminum sulphate and calcium chloride. These materials, when used in conjunction with coagulation and supplemented, if necessary, by flotation, are quite effective in this respect. However, it is difficult to economically dispose of the voluminous watery sludge that is produced.

Soluble oils and emulsions can be intercepted by plain sedimentation, following coagulation. But if the oil content of the waste is such that an appreciable quantity of the sludge formed rises to the surface, then air flotation has the advantage of being able to float essentially all the sludge to the surface for removal along with any free oil present.

The principle of air flotation is to bring in close proximity with the sludge and oil particles tiny air bubbles which attach themselves to the solid particles, thus reducing the specific gravity of the sludge particle to a point where it will rise freely.

Flotation process: The flotation process is not generally understood, so a brief description of how it works will be given. There are two practical methods for introducing the optimum sized air bubbles. The one most commonly seen in practice is one based on the natural laws of solubility of gases in water. A glass of water drawn in one's home at times appears milky white from tiny air bubbles. The water rapidly clears, starting from the bottom. This occurrence usually happens during the winter when the water is quite cold permitting more air to be dissolved in the water. This cold water saturated with air is pumped to your home under pressure. As the water enters the house, still under pressure, the temperature rises, causing the water to be supersaturated with the air, but maintained in solution by the pressure in the line, just as soon as the tap is opened the pressure drops and the air comes out of solution producing the tiny air bubbles in such numbers as to make the milky appearance.

This same principle is employed in commercial air flotation units, with the chemically treated waste being mixed with air under pressures of 30 to 50 psi. This results in a large increase in the dissolved air in the waste. The pressurized liquid is then discharged into a tank open to the atmosphere. The air comes out of solution in minute air bubbles which attach themselves to the sludge particles and literally float them to the surface.

The second technique of flotation still employs the same basic laws, but instead of dissolving additional air under pressure and releasing the air at atmospheric pressure, the method operates by bringing the dissolved air up to saturation at atmospheric pressure, then running the waste through a tank where a vacuum is drawn with a subsequent reduction in pressure, which causes the air to come out of solution.

Both of these systems have been practically applied to the treatment of oily wastes.

Sludge disposal: The most perplexing part of treating soluble oil wastes is the disposal of the oily sludge obtained, which will run from 5 to 20 per cent of the original waste volume, depending primarily on the original oil content, as well as the type and quantity of chemicals employed in treating the waste.

As a temporary measure, some of the more fortunate plants who have land area have disposed of the sludge in pits or holding ponds. The sludge is reluctant to dry or dewater and certainly is not satisfactory as a fill material.

Alternate disposal methods are expensive. The one most commonly applied is incineration of the sludge. To accomplish this, it may be necessary to acidify and heat the sludge to get rid of some of the excess water. The economics of this method depend on the volume of sludge and the relative proportions of oil and water. In most cases, it is necessary to supply auxiliary fuel to support combustion. The residual ash obtained as an end product is suitable for land disposal and represents only an insignificant fraction of the initial sludge volume.

Improved methods—Modification of chemical coagulation and flotation: At the present time, studies are being carried out on the recovery of coagulating agents. The use of aluminum sulphate appears to be the most promising. In this case, the sludge produced as a result of alum coagulation is acidified with sulphuric acid which dissolves the sludge, releasing free oil and acid aluminum sulphate. Providing the initial pH of the soluble oil waste is sufficiently high, the acid aluminum sulphate can be reused as a means of pH adjustment and emulsion breaker combined. The recovered oil may have a small reclaim value, but even that is doubtful. However, many conditions must be met before this system is workable, and such conditions, unfortunately, are not always found in treating soluble oil wastes.

In other respects, the equipment for chemical coagulation, sedimentation and/or flotation of soluble oils has reached a state of development that it is difficult to see what radical improvements may be in prospect.

The phase that needs attention most is how to handle and dispose of large sludge volumes that result from such processes. An efficient method to rid such sludge of excess water so as to reduce its bulk and make it into a burnable fluid, or cake, would be very desirable.

Bio-oxidation: Certain forms of biological processes,

similar to those used for the removal of phenols, cultivate living organisms that feed on oils. Indeed, it has been demonstrated that effluents having relatively low concentration of oil (say 100 ppm or less) can be effectively treated in this manner. The equipment would preferably consist of activated sludge tanks rather than trickling filters, the surfaces of which might be too easily clogged with oil. Such biological plants are not simple and require large amounts of air. They can be attacked by chemical compounds that may at times be present in the influent. The operation must be continuous, and carefully controlled as to temperature, pH and chemical components in the outflow, so that action of the micro-organisms is not inhibited. One advantage of this process would be that it would practically eliminate the sludge problem.

Disposal by municipal sewage treatment plant: Small steel plants, in communities that have modern municipal sewage treatment plants, may be able to dispose of the soluble oils by making special arrangements with the city. Soluble oils, if fed at a regular rate, and up to a certain limit, can be treated without difficulty, together with the sanitary sewage by an activated sludge type of plant. A schedule of charges for such accommodation can be negotiated. In some cases, where the volume of oil involved is not excessive, this may prove to be the simplest and least expensive solution.

Heating and miscellaneous: Cracking of emulsions by heat after prior conditions with chemicals is a common procedure. The free oils thus formed can then be skimmed off by a gravity separator. However, for flows of 100 gpm and over, even if they are not continuous, the heat exchangers and the amount of heat required would make such a process economical only in exceptional cases.

Some new results may come from the research and development that is continuing on how to deal with soluble oils and emulsions. Until then, the best procedure is to use the known chemical and flotation methods in conjunction with maximum reuse of the oils, prevention of spillages, and having enough storage so the treatment is done periodically on a relatively small flow with a high concentration of oil and under controlled conditions.

WASTE PICKLE LIQUOR

General—It is estimated that 35 to 40 per cent and possibly more of all steel products require removal of scale with acid during some step in the manufacturing process. On the basis that some 45,000,000 tons per annum are pickled with acid at the rate of 25 to 60 lb of acid per ton, about 800,000 tons of acid are used for pickling. Assuming a discharge of 25 to 45 gallons of waste liquor per ton of steel treated, somewhat over one billion gallons of waste pickle liquor is generated annually. This estimate and certain other data are taken from G. A. Howell's paper on "Waste Pickle Liquor Disposal" presented before the "Central States Sewage & Industrial Wastes Association"—June 1957.

A variety of acids are used, but as sulphuric acid represents over 90 per cent of the total, other acids will not be discussed. Only a very brief review of the rinse water problem will be included, since it is merely a dilute form of spent liquor.

Quantities and concentrations—The ultimate disposition of the total free acid used is approximately as follows: in waste liquor 60 per cent as $FeSO_4$ and 25 per cent as free acid, the remaining 10 to 15 per cent in the acid rinse water.

The waste pickle liquor from batch processes may contain 0.5 to 2.0 per cent of free acid and 15 to 22 per cent ferrous sulphate. In the continuous process, the composition may be from 5 to 8 per cent free acid and 14 to 16 per cent ferrous sulphate.

Since the continuous method is presently more widely used, it can be estimated that a total annual discharge of say 1,000,000,000 gallons of spent liquor contains some 275,000 tons of free acid and possibly 650,000 tons of ferrous sulphate.

The spent liquor often contains undissolved scale and dirt and is usually discharged at about 190 F. In certain processes, this high temperature can be utilized to facilitate the separation of ferrous sulphates.

Design considerations—Uniform quality criteria with respect to acids in waste effluents would not be justified. Discharges that would be injurious in one case, for instance where the stream flow is small and clean, might be acceptable if the river flow were large, or already carried a high percentage of acid mine water. Clean acid discharges in moderate quantities may actually be beneficial if the river water is very hard. Certainly there are many plants where rinse water, at least should not have to be treated at all. The spent liquor, however, must be disposed of in such a manner that it does not destroy aquatic life or inhibit the natural bio-oxidation processes of stream self-purification.

Some regulatory authorities, depending on the location of the zone and other factors, require varying degrees of treatment. In all cases, good housekeeping practices are demanded, which would minimize the escape of acid pickle liquor. The most general regulation specifies that the final effluent contain not over 25 per cent of the acid used and the total iron content of all the plants waste waters not exceed 225 lb per ton of total acid consumed. The strictest standard of treatment may permit only 15 per cent of the above amounts.

Present methods—There are about 100 known processes for treatment of spent liquor, either with or without the recovery of sulphur or iron in some form. Over a dozen of these are reviewed in the publications of ORSANCO. Only a few of the methods most commonly used can be mentioned here.

Dilution: The simplest method is to limit as much as possible the discharge of acid wastes by reuse and other conservation practices and to dilute what discharge there is with large quantities of other waste effluents. In certain cases, this results in a harmless effluent. In the future, however, it will be found increasingly difficult to obtain acceptance of this procedure.

Underground disposal: Small volumes of waste pickle liquor can, where geological conditions are suitable, be discharged into wells, depleted salt domes or oil fields, or into underground limestone formations. Only a few minor steel finishing plants can take advantage of this method.

Absorption by slag: Where large slag dumps are available, spent liquor can be discharged into same. One of the ways in which this is done is by creating

lagoons in the mass of slag. Where space is available, waste pickle liquor is poured over hot slag and thereby absorbed and vaporized. No noticeable air pollution is apparent a short distance away.

Still another method is used in the Pittsburgh area. The spent liquor is brought to a privately owned plant where it is mixed under controlled conditions with granulated slag. The lime in the slag completely neutralizes the acid and the end product is a stable material suitable for fill.

A variant of this method is used in the Ohio River Valley and on the West Coast. The acid is poured onto the granulated slag that is to be disposed of. It is soaked up and at least partially neutralized by the slag. The waste material is then shipped out by train, barge or ship to some suitable site for disposition.

Discharge to municipal sewers: As in the case of underground disposal, only small discharges of waste pickle liquor can be sent to a municipal sewage treatment plant. Such disposal must be negotiated with the municipality. The free acid must first be neutralized before discharge into the sewer. To prevent the formation of excessive sludge, soda ash, which is relatively an expensive chemical, is commonly added to the effluent. The rate of discharge of waste liquor must be controlled. Furthermore, the operation of the sewage treatment plant is complicated by the increase in the volume of sludge and by clogging of the air diffusion plates and other equipment. For all these reasons, the wide application of this method is not likely.

Use by industry and for other processes: Certain paint pigment manufacturers use waste pickle discharges. The total demand is much less than the total discharge of spent liquor, so that only a few of the steel plants, favorably situated close to points of consumption can get rid of the waste in this manner. The steel company usually pays handling and transportation charges to the paint factory. This method has the advantage of minimum capital investment. In one instance, waste pickle liquor is trucked to a municipal sewage treatment plant for use in conditioning sludge prior to vacuum filtration. There is, however, a definite limit to the volume of liquor that can be disposed of in this manner.

Neutralization: Neutralization is the most prevalent technique for treating waste pickle liquor. Voluminous literature is available on the various materials and methods used. Essentially they all involve the reaction of such materials as lime, slaked lime, dolomite, carbide sludge, etc., with the acid. The drawback of this type of treatment is the difficulty in dealing with the large volume of watery sludge which is produced.

The equipment required is fairly simple, but the entire operation, including handling and disposal of the sludge, depends on the availability of sludge disposal areas.

Precipitation of ferrous sulphate: There are a number of slightly different evaporative processes by which a large part of the excess water in spent liquor is driven off. The simpler methods are based on separating the waste substances by precipitating ferrous sulphate in the form of sulphate heptahydrate (copperas), leaving a weak solution of sulphuric acid with some remaining ferrous sulphate. This solution, or "blowdown," can usually be reused for pickling steel by mixing it with fresh acid. If such recycling is, for some reason, impractical, prior reaction of the waste liquor with scrap or iron ore will produce only sulphate heptahydrate and water.

In either case, the problem is what to do with the copperas. It is a material for which, so far, there is only a very limited demand. It contains about 45 per cent water and leaches out very easily, which means it cannot be used as fill material. The process involved is fairly simple, but the evaporating and condensing equipment for a large volume of spent liquor waste would be expensive and cumbersome. In Germany, several plants of this type, serving picklers handling several hundred tons of steel per day, are in operation. Research is continuing to find uses for the copperas. No data has been found on any large evaporative type installation in the United States.

Improved methods.—More efforts are being made to develop improved methods for waste pickle liquor disposal than for any other water-borne waste from steel plants. First, there are inventors, allied with chemical and equipment manufacturers, trying to perfect some special, usually patented, process that would also recover the valuable by-products in the liquor. Then there are steel companies experimenting with pilot plants based on a process deemed best adapted to the specific conditions of their plant. Finally, there is cooperative research, carried out by the Mellon Institute and universities, in some cases, with the participation of ORSANCO, and the Steel Industry Action Committee.

A complete acid recovery process is now available, but the initial investment required is considerable and operations must be carefully controlled, all of which makes it most economic where large discharges of spent liquor are involved. Various improvements of the better known methods are briefly reviewed below.

Absorption by slag: Several cases have been observed where the introduction of waste liquor into large deposits of slag have resulted in no escape of acid into adjacent water bodies. Where conditions are suitable, a careful survey of the flow conditions and properly planned and controlled disposal of spent liquor in this manner would represent an economical solution.

Treatment with coke, oven, gas: The ammonia and hydrogen sulphide in the gas react with ferrous sulphate in the liquor to form ammonia sulphate and ferrous sulphide. The iron sulphide is oxidized with air or oxygen to ferric oxide. Elemental sulphur is liberated in this step and later recovered by flotation as a 95 per cent pure by-product. One phase of the process involves the recovery of iron ferrocyanide. Pure white ammonia sulphate is crystallized from the final liquor.

The advantage of this process is that the waste pickle liquor replaces the large quantity of fresh acid needed to improve the quality of the gas. Iron oxide is produced that can be sent to a sintering plant, and also ammonia sulphate. The latter is in excess supply, but presumably can at least be disposed of at no great cost.

The disadvantage is that the equipment required would not be simple and due to the lack of balance between the volume of coke oven ammonia and pickle liquor, existing ammonia saturators would still be necessary.

No reports are available on a full-sized treatment plant of this type. When further development work

has been done on this process, it may be possible to determine under what conditions it would be economically applicable.

Production of monohydrate: Waste pickle liquor can be concentrated by evaporation at a temperature above 120 F to crystallize out ferrous sulphate monohydrate. This occurs because the solubility of ferrous sulphate in sulphuric acid decreases as the acid concentration increases. If the acid concentration can be increased, then the ferrous sulphate will be precipitated.

In the process, the concentration of the acid in the spent liquor can be raised to 35 per cent with only 7 per cent dissolved iron salts. Such a composition permits the reuse of this liquid in pickling operations by mixing it with fresh acid and rinse water as required.

Approximately one-third of the total acid requirements can be met in this manner. The by-product is ferrous sulphate monohydrate, and its advantage over the more easily produced heptahydrate is that it contains less water.

The ferrous sulphate in the form of monohydrates can be roasted together with pyrites for conversion into the sulphuric acid and iron oxides.

The steps consist of evaporating the water in the spent pickle liquor with hot gases, adding fresh sulphuric acid, precipitating the iron sulphates, and recovering it by a filter as a monohydrate.

It is claimed that this process is considerably cheaper in overall operation than the lime neutralization process, and is particularly advantageous for high acid method of pickling and if a pyrites roasting plant is located in the vicinity.

Several commercial size plants based on this method have been built in Germany. This Martin-Inland-Zahn process is being offered in the United States and is described in a paper presented at the 1957 Annual Convention of the AISE, by James S. Joseph and Elbert T. Culver entitled "The Dollars and Sense of Pickle Liquor Treatment." It will be published in a future issue of the *Iron and Steel Engineer*.

Complete acid regeneration: A new method, known as the Ruthner process, for the recovery of the pickle liquor as reusable sulphuric acid has been developed in Europe. The only by-product is iron oxide, which can be utilized by the steel plant. Therefore, the waste disposal problem does not arise. Hydrochloric acid is the only raw material for process makeup normally needed.

In simplified form, the operation consists of the following: evaporating some excess water from the waste pickle liquor and treating the remainder in a reactor with hydrogen chloride gas to produce ferrous chloride and sulphuric acid. The effluent is centrifuged to separate the sulphuric acid which then goes to a degasser. The ferrous chloride goes to a roaster and is converted into iron oxide and hydrogen chloride gas. The degasser produces recovered acid and hydrogen chloride gas which is fed to the absorber and stripper. The recovered acid is fed back to the pickling line and the hydrogen chloride gas, after absorption and stripping, is fed back for recycling.

The principal input is heat. Small quantities of sulphuric and hydrochloric acid will be required for makeup.

This process is particularly well adapted if the high acid method of pickling steel is used. The waste liquor in such cases contains 25 per cent free acid and 14 per cent ferrous sulphate, expressed as $FeSO_4$. The evaporation load is reduced and it eliminates the necessity for recirculating recovered acid in order to get the benefit of all the recovered acid produced at the plant. The size of the equipment and piping is reduced. Under these conditions, the total cost of recovering acid is less than half as with the ordinary pickling method.

A pilot plant, recently completed, was sponsored by a group of seven steel companies in Niles, Ohio. The actual operating results will be awaited with interest. Certain simplifications and improvements in operating procedures are being made.

The main problem is that the process, though simple in principle, requires an elaborate plant. One has to deal with highly corrosive liquids and the initial costs are rather high. However, where conditions are suitable, the investment may be economically justified.

The most obvious and advantageous application of this process is at steel mills where: (a) high acid method of pickling steel can be used; (b) the volume of steel treated is large; and (c) the disposal of pickle liquor by other methods is difficult and expensive. Under such conditions it is claimed that, besides solving the treatment and disposal problem, acid can be produced at a total cost of only $15.00 per ton.

Miscellaneous: Studies are continuing on a number of other processes. Some would convert the sludge resulting from neutralization with alkalis into building materials or a stable fill material. Another method would utilize low grade manganese ore. Space does not permit reviewing these efforts.

The economic inducement to perfect methods of waste pickle liquor disposal are increasing as limitations are put on the discharge of acid wastes into water bodies. All the activity should result in perfecting several processes which could thus pass the experimental stage and become available for full-sized application. Then, steel plants will be able to choose from several alternate solutions, the one that best suits their particular problem.

PHENOLS

General—Phenols takes one into the great realm of organic chemistry. Their interception to the degree desired by the pollution control authorities is an intriguing and often baffling problem. The well known nuisance characteristics of phenolic compounds are the objectionable tastes and odors they give to water even when present in minute quantities.

Phenol wastes originate in the coke plant, and the largest concentrations are in the condensate from gas coolers. Smaller amounts come from light oil decanters and in still more dilute form from miscellaneous minor sources.

Among the groups working on phenolic wastes, the Steel Industry Action Committee, working in cooperation with ORSANCO, has issued interesting data on the following aspects of the problem: the discharge of phenols by coke plants; the workings of dephenolizing plants; and the various processes that have been tried to limit phenolic compounds in the final effluent.

The scientific aspects cannot be covered, and the present discussion will consist merely of a review of the problem and of a few of the more developed processes

that may be combined to reduce the phenol content to meet strict, but not unrealistic, effluent quality standards which are being evolved.

Some steel plants have constructed dephenolizing plants for the removal and recovery of most of the phenols. Usually only the ammonia still influent or discharge is treated. Two different processes are used. One based on liquid extraction, and the other on vapor recirculation. Up to 98 or 99 per cent of the phenols can be recovered by the latest liquid extraction process. However, the records at many plants show that the performance of the older dephenolizers is considerably lower, bringing the phenol concentration in the effluent from the dephenolizers up to as much as 100 to 200 ppm. When you add to this the phenol contained in the discharges from the light oil decanters and from miscellaneous sources, the need for further reduction of phenols (following dephenolizers) is often necessary. This section deals mainly with the secondary treatment (following dephenolizers) and its related problems.

Quantities and characteristics—Various types of coking and chemical recovery plants are presently in operation. Since there are differences in the chemical composition of the coal and processing methods used in each coke plant, there is no generally applicable data available from which valid estimates can be made of the amounts and concentrations of various phenolic compounds that must be given final treatment. Nevertheless, some typical figures are presented below as a basis for discussion of the processes involved.

The total amount of phenols in the discharges from a coke plant (ahead of dephenolizing) is usually between ¼ and ½ lb per ton of coal carbonized. The total amount of phenol-carrying water discharged may be in the order of 35 to 50 gallons per ton of coal. Approximately half of this is the condensate from the gas coolers. Representative concentrations of phenol in this effluent may be from 1000 to 2000 ppm. In the discharge from the light oil decanters, the concentrations may be 50 to 150 ppm and 10 to 50 ppm in the effluents from miscellaneous sources.

If we assume that most fair-sized coke plants will use new efficient dephenolizers, and that these will remove 95 to 99 per cent of the phenol in the gas cooling condensate, and then add the discharge from the light oil decanters (without passing it through a dephenolizer), the combined effluent from the coke plant that may have to receive secondary treatment would have the characteristics given in Table IV.

TABLE IV

Representative Influents of Phenol-Carrying Wastes to Secondary Treatment Plants
(assuming average concentration of phenol of 100 ppm)

Size of coking plant, tons of coal per day	Discharge in gpm	Phenol to be treated, lbs per day
1000	25	30
2000	50	60
4000	100	120
8000	200	240

In this review, one can only touch on a few of the main points with respect to the physical and chemical characteristics of phenolic compounds. An authoritative study of the causes of taste and odor in water was made by Dr. Richard D. Hoak of the Mellon Institute. His findings on odor thresholds (the point or concentration at which odor becomes apparent) show a striking difference in odor potentials among a number of related phenolic compounds. While pure phenol's threshold is ½ to 1 ppm, certain chlorophenols and dichlorophenols have thresholds of about 1 part per billion. So far, no full-sized treatment method has been developed to reduce concentrations to anywhere near such a low figure. Certain compounds have a lower threshold concentration at 30 F than at 60 F.

The tendency for the odor characteristics of phenolic substances to alter radically with minor changes in chemical structure is a complicating factor in the development of treatment processes. One must take this into consideration as the phenol-carrying discharges from a coke plant, even if it is equipped with a dephenolizer, vary in terms of the total amount, the concentration, and the distribution of the different phenolic compounds. Much additional research in this field is needed before an adequate understanding of the phenomena involved is reached.

Design considerations—Before a phenols treatment plant can be designed, the quality criteria for the final, and preferably total, effluent into the water body must be established.

The ultimate aim of regulatory bodies is to see that the phenolic concentrations in plant effluents are reduced to a point where they do not constitute a nuisance. Requirements should not be arbitrary. Phenols have been found in waters remote from industrial works. They are contained in sewage and may be generated by decomposition of various natural organic substances found in the source of supply. Phenols can be oxidized and eliminated by the life processes going on in the body of all streams. In establishing quality criteria, consideration should be given, therefore, to the quantity and quality of the water in the receiving body, to the deconcentrating effect of available dilution and of natural oxidation, and to the use that the water will be put downstream.

The design of dephenolizers will not be discussed. They are usually supplied by chemical process manufacturers, and, as explained further in this chapter, certain almost standard installations have been perfected.

Other phenol treatment installations that have been successfully used are based on oxidation of the phenols and are either of the chemical or biological type. The chemical oxidizing agents used are chlorine, chlorine dioxide or ozone. The amount of chemicals consumed to reduce the phenol concentrations say to 20 to 50 ppm is very large, but possibly not excessively so. The processes involved are quite simple. On the other hand, the plant needed to generate chlorine dioxide and ozone is extensive and costly. Beyond the degree of removal described, much more elaborate facilities and disproportionately larger dosages of chemicals are required, and no new designs have been reported that have overcome this difficulty.

Several variations of the bio-oxidation processes have been developed. Much scientific and laboratory information has been published. The most common methods use low loading rates for trickling filters, or prolonged aeration periods for activated sludge. Several full-size bio-oxidation plants for removal of phenols

have been built for oil refineries. Design criteria for these processes are currently being established, but no technical data directly applicable to secondary treatment of coke plant wastes is so far available. As a result of all the activity in this field, one can anticipate that soon a basis of design for bio-oxidation treatment suitable for steel plants will be worked out.

Present methods—Dephenolizers: A brief review of the extractive type of dephenolizers should precede the discussion of the more complete methods with which this chapter is primarily concerned.

The process industries have contributed two types of extractive dephenolizers. One based on liquid to liquid contact, and the other on vapor recirculation. The latter type is becoming less common.

Extractive dephenolizers usually treat only the gas cooler condensate. Concentrations in the light oil decanter wastes and from miscellaneous sources are generally so low that a separate section would have to be added to the dephenolizer. If further treatment is to be provided, these oil decanter and miscellaneous wastes can be fed directly to such second step facilities.

The liquid to liquid dephenolizers use a solvent that is passed counter-currently through a tower, or a centrifugal extractor, with the waste, in order to extract the phenol. Then the phenol is stripped from the solvent by caustic, yielding a condensate consisting of crude sodium phenolate. In turn, the phenolate may be further treated by an outside refinery for production of phenol.

The vapor recirculation process does not use solvents. It brings the waste, steam, and caustic into intimate contact. The caustic strips the phenols from the waste, and in turn the phenol may be recovered. However, with this method, the removal of phenols is not high and may average less than 90 per cent.

None of these processes are self-supporting. Sodium phenolate brings only ten cents to fifteen cents per gallon, and this does not begin to meet the fixed and operating charges.

A dephenolizer cannot by itself reduce phenolic concentrations sufficiently to satisfy some of the anti-pollution requirements now being considered. Average performance figures of dephenolizing units are often quite high, but since the rates of discharge and concentration of phenolic wastes are not consistent, efficiency actually ranges between 90 and 99 per cent. Dephenolizers are, however, a valuable, and in some cases essential, means of greatly lightening the phenolic waste load for secondary treatment, and thereby the size and cost of these facilities. It is therefore appropriate that at many coke plants dephenolizers should precede other forms of treatment.

Disposal by dilution: Phenolic wastes are mixed with other effluents and the combined waste is then discharged into a body of water sufficiently large to reduce the phenols concentration to acceptable levels. Usually this can be contemplated only after installing a dephenolizer, or some other process, for interception of the bulk of the phenol produced.

Closed systems and evaporation in the quenching station: In certain coke plants, the effluent from a dephenolizer, and the other phenol carrying discharges, enter a closed system and are consumed by, or vaporized, and mixed with the gases produced in the quenching of coke. This may result in a certain amount of atmospheric pollution, which, due to the calcium chlorides that are also vaporized in the process, greatly accelerates corrosion of all exposed metals in the vicinity. Under this method, any overflows or spills from the quenching station must be prevented.

Chemical treatment: Phenols can be neutralized by chemical means. The three most important oxidizing agents are: chlorine, chlorine dioxide and ozone.

Chlorine is the easiest to use, and its cost per pound is moderate. However, the operation is tricky. If the dosage falls too low, the phenols can be converted to chlorophenols. These present a worse treatment problem than the original phenols. Chlorine treatment is also sensitive to pH and temperature. An excessively large quantity of chlorine is required to get the phenol concentration to the very low limits being sought. So far, no economic method of relying on chlorine alone has been proved.

Chlorine dioxide and ozone must be generated on the job. They, however, are not as sensitive as chlorine to operating conditions and they do not produce complications if underfed. They are, however, more expensive than chlorine. Ozone requires a large initial investment but has relatively lower operating costs. Chlorine dioxide, on the other hand, requires a lower investment, but has higher operating costs.

Although all three chemicals will produce good results in the initial reduction of phenols, getting rid of the last trace of phenols is like trying to squeeze the last drop out of a toothpaste tube—there always seems to be a little more.

Chemical treatment is expensive and must be evaluated for each problem. For small quantities of waste, it may be economical, but for larger discharges requiring removals in the order of 99 per cent, it has not so far been found very practical.

Biological treatment: Biological treatment consists of feeding the phenolic wastes to active groups of bacteria. The bacteria are able to utilize the phenols for nourishment and to oxidize them into inoffensive by-products. All this must take place in the proper environment—temperature, pH, nutrient supply, etc. If the amounts of phenols to be removed are not very large, shock loads can be equalized by lagoons.

The trickling filter has bacteria living on the surface of stone or other media in a bed. Waste is distributed over the media and the bacteria adsorbs the pollutant matter as the waste passes by.

In the activated sludge process, bacteria is suspended in the liquid contents of a tank and their growth and feeding on phenols is stimulated by large volumes of air blown through the liquid contents of the tank.

In both cases, various auxiliary operations such as chemically conditioning the inflow, supplying nutrients, backfeeding the sludge and so forth are involved.

Bio-oxidation is not a cheap or simple process, but the operating costs are much lower than for chemical oxidation and give a high degree of phenol reduction over a comparatively wide range of influent concentrations. The bio-oxidation process has, so far, not been economically adapted to such large discharges of phenols as come from coke plants. It would appear quite suitable as a supplement to dephenolizers. The two stage treatment could effect removals of over 99.5 per cent.

Further improvements in the biological process may obviate the use of dephenolizers altogether. This solution may be complicated at some plants by the problem of finding the necessary space for all the tanks required. The present status of this method is that it is best suited for secondary treatment.

Adsorption by activated carbon: This process involves mixing an appropriate quantity of carefully graded activated carbon with the phenol carrying wastes and maintaining contact for some minutes. The carbon particles are then separated from the liquid with the use of flotation equipment. An alternate method is filtering the waste through a bed of activated carbon. In both cases, the spent carbon must be replaced or reactivated by a special type of heating process.

With the selection of the proper activated carbon-phenol ratio and contact time, it is possible to obtain almost any desired degree of phenol removal. However, activated carbon may be adversely affected by other chemicals in the waste flows and its economic application to coke plant wastes has not yet been proven.

Treating the phenol waste in municipal sewage treatment plant: Several years ago, Gary Coke Works of the United States Steel Corp., in conjunction with the City of Gary, Ind., demonstrated the feasibility of treating ammonia still wastes, together with domestic sewage at the municipal activated sludge plant.

The presence of the still wastes in the sewage did not, over the six-month period of the test, interfere with the normal operating efficiency of the treatment plant. At times the phenol loading amounted to as much as 2000 lb per day with a 9 to 1 dilution factor. After dilution and activated sludge treatment, 99.7 per cent of the phenol was destroyed, providing an average phenol concentration in the effluent of 5 ppb.

Because of more or less fixed operating conditions in the treatment plant, it was difficult to estimate minimum operating conditions and requirements for the combined treatment of domestic sewage and ammonia still wastes.

Improved methods—Liquid extraction type dephenolizers: The effectiveness of benzol or light oil extraction type dephenolizers has been improved. One of the processes is continuous and uses counter-current centrifugal extractors. After the benzol has adsorbed the phenol in the first reactor, the phenol carrying liquid is pumped to a second extractor. A caustic solution is used. The dephenolized benzol leaves the extractor and is pumped back to the dephenolizer for further use in the removal of phenol, thus completing the cycle. The crude sodium phenolate produced is delivered to receivers where it is concentrated by the application of heat and made ready for marketing.

Under actual operating conditions, 98 to 99 per cent of the phenols in the condensate from the gas washers have been removed, leaving a concentration of from 20 to 40 ppm. This concentration can be further reduced by using 25 to 50 per cent more caustic. Additional equipment of similar nature could be used to treat the effluent from the light oil decanter, but the relative effectiveness of such an installation, due to lower phenol concentrations, would be less and so far hardly any dephenolizers have been used for the more dilute phenol carrying discharges.

The other method is a semi-batch process that uses cascade tray type contactors or Koch towers. The chemical reactions and the results are somewhat similar to the liquid extraction process.

The improved dephenolizers offer an effective method to knock out the bulk of the phenols produced by the coke plant. Secondary treatment may be necessary, however, if phenol concentrations of less than 10 to 20 ppm are to be achieved. The reclaim value of the phenol produced in both cases is not significant.

Multi-stage process: Recent work has centered on using combinations of the methods previously described.

For example, a purely chemical method would consist of first treating the waste in a dephenolizer, then storing the effluent from the ammonia still and from the other sources to equalize the composition of the flow to be treated by chemical oxidation.

Bio-oxidation can be used instead of chemical oxidation. This can consist of either activated sludge tanks or of trickling filters. Other two, or even three, stage processes can be worked out (see Figure 11).

What then is the advantage of using multi-step treatment? There are several. First, each process is chosen to remove that range and degree of phenol con-

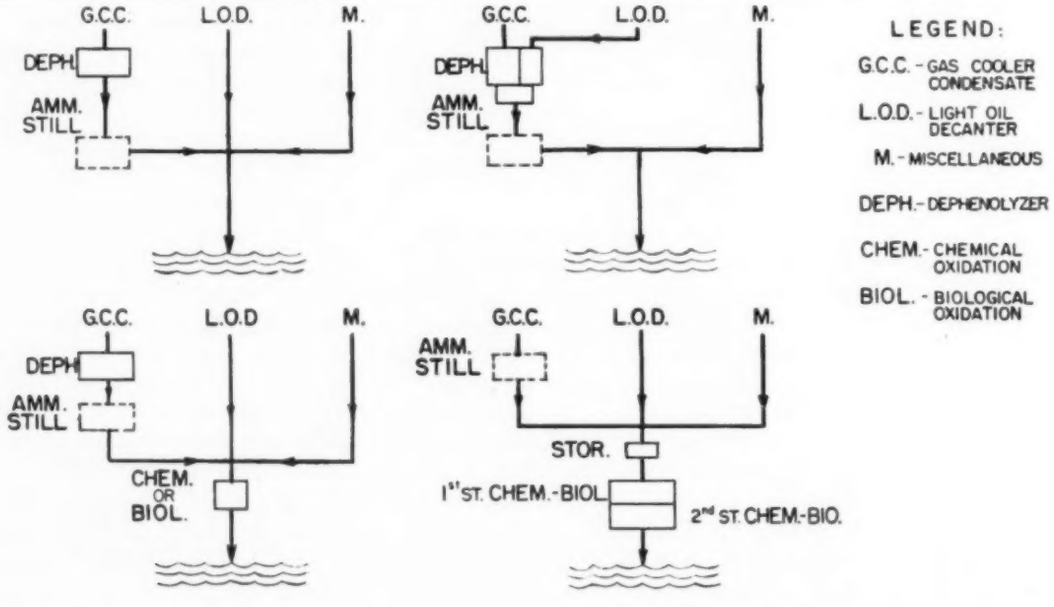


Figure 11 — Flow sheets show various possible methods for removing phenol.

centration which it can handle most economically. The enormous demand for chemicals required by a single stage process to knock out remnant quantities of phenols can be circumvented. Second, multiple processes provide a measure of safety and flexibility. Shock discharges of phenols can be handled and operating breakdowns of a single piece of equipment would not be too serious. Third, the complete plant can be more easily designed to handle future increases and changes in the character of the waste and meet stricter effluent quality standards.

GRANULATED CINDER

General—Water borne granulated cinder is considered to be in a special category from other wastes, as granulated cinder carrying effluents are not common to all steel plants.

Most of the slag produced by steel plants is removed from the blast furnace area in a molten state by means of railroad ladle cars, and dumped in slag piles. In such cases, there is no granulated cinder problem. At other plants, all or part of the slag is quenched. This expansion or granulation is done using water alone, or in various combinations with steam and air. Different types of cinder are produced in this way.

We deal here with any excess quench water and the very small amounts of cinder that are unavoidably carried by this water. Depending on the cinder-making process followed, the rates of discharge to be dealt with vary widely. Treatment installations and costs obviously are higher if the volume of water to be treated is larger. This makes it difficult to draw any general conclusions. Too much depends on the relative size of the effluents to be treated.

Although in many cases the water discharges from cinder pits may seem clear, there are always some cinders carried in suspension. The principal objection to such effluents is the presence of cinder particles, which are of a highly abrasive nature. Cinders cause trouble to bathers and injure pumps and other equipment of any shipping in the vicinity. Some particles will float on the surface, so that, even if present in small quantities, the effluent is unsightly in appearance. For these reasons, in many cases, discharges from cinder tanks will have to undergo treatment.

Quantities, characteristics and design considerations—The amount of molten slag tapped from a blast furnace varies between 30 and 40 per cent by weight of iron produced. This means that, assuming a blast furnace production of 80,000,000 tons per annum, some 25 to 30,000,000 tons of molten slag per year must be disposed of. Probably somewhat less than half of this total is quenched, i.e., expanded or granulated in some manner.

The actual amount of cinder laden waste water that must be treated before it is allowed to join the water body depends on the slag cooling process used. Some commercial operations for "expanding" slag are based on the use of air and steam and require only enough water for quenching purposes. In fact, the operation is planned so as not to have any liquid effluent at all. Even with such a process, almost always there are some small irregular discharges of cinder carrying water, due to overflows from pits, spillages, washdowns, etc., that must be properly disposed of. In most cases, this proves not to be as easy as it may seem.

More than 99 per cent of the cinder produced is disposed of by railroad cars or trucks as a wet loose material. The effluent one has to treat carries only the remaining small fraction (usually about ¼ to ½ per cent) which is caught up by the waste water discharge. Additional amounts of slag particles may also reach the sewers by dribblings from buckets and cars during the cinder loading and disposal operations. Consequently, these spillages must also be intercepted and treated.

The typical chemical composition of slag from furnaces using ordinary Mesabi ore is shown in Table V.

TABLE V

Slag	Per cent
CaO	44
SiO_2	37
AL_2O_3	9
MgO	5
Sulphur	1.5
Miscellaneous	3.5
	100

Part of these elements dissolve in the water used for quenching, expanding, or granulating the slag.

The density of slag is about 2.6. However, due to the porosity of the material produced by the granulation process, the bulk specific gravity of individual particles varies between 0.8 and 1.6. Most of these particles will sink; a small part will float. In either case, such particles can be easily intercepted and disposed of by ordinary material handling equipment. There is, however, a small portion having a bulk specific gravity of about 1.0 that will neither float nor sink. This material cannot be collected by gravity separation and must be screened out. How to do this effectively under the adverse conditions close to or within the usually crowded blast furnace area constitutes the main problem.

Present methods—At most plants where slag is quenched or cooled, it is stored in pits until it can be loaded into railroad cars or trucks and taken away. At plants where large discharges are not used to transport the cinders, or for other purposes, the average effluent rate, consisting only of occasional overflows and spillages, may be quite small, i.e., 100 to 200 gpm per furnace, or even less. The entrance of cinder particles into the sewers is partially prevented by baffles at the outlet of the tank and by using the pile of cinders itself as a filter. These procedures do not intercept all the particles, a small fraction of which escape to the sewer. If the sewer outfall is near a beach or close to a navigable channel, treatment of all the cinder carrying effluents may be imposed. In all cases, the treatment consists of some form of screening.

When the effluent amounts to several thousand gpm per furnace, a much larger screening installation must be used. Several types of screen units have been developed for this purpose. The conditions under which they have to operate are not favorable. The majority consist of rotary screens. These are equipped with removable panels of fine mesh screen, and have provisions for backwashing. The effluent that is to be screened is hot and surcharged with various dissolved chemicals. Corrosion may occur during certain periods and in-

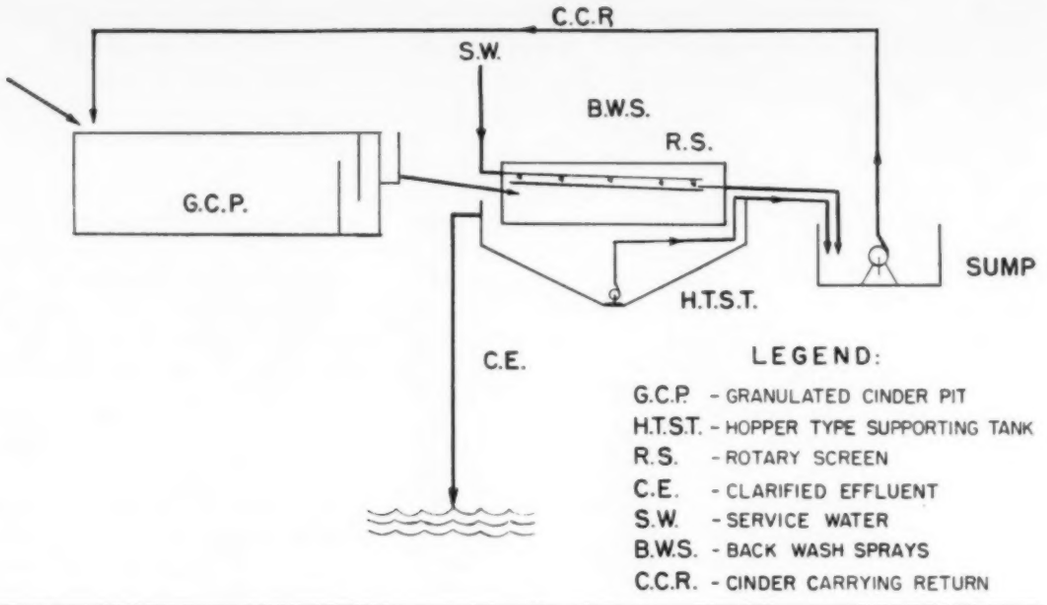


Figure 12 — Flow sheet shows one method for screening granulated cinder.

crustation during others. The screens are subject to wear and abrasion. The available hydraulic head is usually limited. Gases from the blast furnaces, which are generally located close to the pits and screening units, and those resulting from quenching operations are hazardous. Additional difficulties arise in properly locating and connecting the screens to the necessary ancillary units in already congested areas.

At some steel plants where the flows are not too large, rectangular-shaped fine bar screens with self-cleaning features have been used instead of rotary screens.

Due to the aforementioned operating difficulties, existing granulated cinder treatment plants do not function very well. The screen units stall, or must be taken out for repairs. Then they are bypassed and the cinder carrying effluents reach the sewers without treatment. As anti-pollution regulations become increasingly strict, the older screening plants will have to be upgraded or replaced by entirely new installations.

Improved methods—In planning granulated cinder treatment facilities, it is best to first separate cinder pit effluents from any gas washer discharges. The presence of flue dust seems to accelerate the tendency some dissolved chemicals have to precipitate on the walls of pipes and sewers causing sewer blockage. It is best to separate completely the effluents from the cinder pits and the discharges from the gas washers.

Only the more difficult problem of treating relatively larger cinder carrying discharges will be briefly mentioned. For these discharges, the most suitable equipment consists of specially designed rotary screens. The fine bar screens previously mentioned can only be used in handling smaller volumes of cinder carrying flows.

The first step in the design of rotary screens is selecting units with screens of the proper mesh size. The total screen area must be proportioned to the maximum anticipated flow. As has been noted, provision must be made for easy removal and replacement of screen segments. The screens must be of tough, corrosion-resistant metal, and able to be effectively backwashed. The small amount of intercepted cinder particles carried by the backwash are fed back to the head of the pit, where they are given another opportunity to get engulfed in the main mass of the cinders in the pit. This usually means pumping an abrasive discharge with all the problems this sort of an operation involves.

Improved granulated cinder treatment requires much more than just a good screening unit for each pit. The operation is more effective when the effluent from at least two pits, and preferably all the cinder carrying discharges are brought to a central plant. There a standby screen can be installed to eliminate by-passing caused by nonoperative units.

Pumping of the entire discharge from the cinder pits is needed where there is insufficient head for the screening operation.

The screening process is very simple and is shown on Figure 12. However, the working out of a project in detail is complicated by adverse operating conditions. This is why each cinder treatment project requires its own study and the selection of special equipment.

TREATMENT COSTS

General—No review of wastes treatment requirements and processes would be complete without some discussion of the economics involved, however difficult that may be. Cost figures, concerning installations which are subject to so many different factors, can be used only if the qualifications by which they were arrived at, are thoroughly understood. The data in this chapter is mostly in the form of representative unit costs and estimates, applicable to medium-sized integrated steel plants that have no unusual features and which are obliged to provide complete treatment of water-borne wastes to meet typical anti-pollution regulations.

To use this background information in making the first tentative estimate of the cost of a specific wastes treatment program, all the assumptions which were used should be studied. Then one must take into consideration the production facilities of the mill in question, its existing wastes handling and treatment installations, the anti-pollution regulations the plant will have to meet, and finally, the available methods of treatment that are most suitable for each of the wastes.

Cost factors—Under this heading, certain explanatory

remarks will be made on each of the principal waste substances. This will be followed by a table giving the probable range of costs for the respective treatment installations required.

Flue dust: Comprehensive new facilities for handling and treating gas washer effluents and for flue dust recovery include collecting sewers, pumping station, thickeners, sludge handling and vacuum filters, but not the sinter plant.

Besides the characteristics of the furnaces, the principal determining cost factors in each case are effluent quality standards (for example, whether flue dust concentration can be 10 grains per gallon or must be in conformance with other criteria), the difficulty of locating the necessary units and the amount of sewer work and pumping required.

At old plants, if high standards of treatment must be achieved, it may be difficult to utilize the existing sewers and thickeners. This and the cost of removing obstructions and replacing displaced installations may make a partially new project more expensive than building complete facilities for a new plant.

If sintering capacity is available, and flue dust is not being effectively recovered, a flue dust treatment project will give a very good return on the investment. Conversely, in case wet flue dust is already being utilized by the plant, the return from more complete reclamation will not be notable.

Mill scale and oils: Every new mill will include one or more scale pits of one type or another. Due to the considerable depth and heavy type of construction required, the installation of even simply designed pits is very expensive. Secondary treatment, or combined scale pits of improved design, that can continuously insure a clean effluent, including the ancillary items, might cost two to three times as much as a single conventional type pit.

Due to the high reclaim value of scale ($10.00 to $20.00 per ton), the resulting increased recovery of scale, the elimination of the cost of cleaning sewers and of dredging out scale from the water bodies can mount up and go a long way to offset the large cost of such improvements.

Most of the free oils and greases originate in the hot rolling mills. The installations for dealing with free oils usually form part of the improved scale pits. The cost of such oil interception, handling and disposal facilities may add 5 to 10 per cent to the cost of just a mill scale treating installation. No economic return can be expected from the recovery of these free oil wastes.

Soluble oils: Recirculation of oil-carrying discharges is assumed. Otherwise, the cost of the complicated facilities required for intercepting soluble oils would be prohibitive. Costs of the recirculating systems are not included as they are considered part of manufacturing.

The cost of getting rid of excess water prior to disposal of the oily sludge by incineration is included. Operating costs comprise the use of chemicals. There is no economic return from these operations.

Waste pickle liquor: The variety of processes and conditions at different steel mills is so great that only a few general comments can be made.

Disposal by dumping onto slag piles, or by dilution, may be economical. The necessary installation would consist mostly of pumps and sewers for handling the waste pickle liquor. Such items, however, can be quite expensive. Acid sewers of permanent construction have cost up to $100.00 per lineal ft.

Neutralization involves fairly high operating costs, but relatively low capital costs. The economics of this method, in great measure, depend on how easily the sludge can be disposed of.

Very little cost data is available on any of the special treatment methods that have been reviewed. It would appear, however, that, if the capital can be found for a large enough acid regeneration plant, the overall costs of treatment can possibly be completely offset by the recovered acid and the iron oxides.

Phenols: The treatment of phenols will usually be carried out in two stages. The first consists of a dephenolizer; the size and cost of which is related to the amount of coal coked. The reclaim value of the recovered phenols is negligible.

The second phase would comprise chemical or biological treatment; the cost of which would also depend on the size of the coke plant, but even more so on the degree of removal of phenols required. There is no recovery of phenol from secondary treatment.

Granulated cinder: The cost of granulated cinder screening facilities will primarily depend on what proportion of slag is disposed of in this way and the method of quenching. If a relatively dry process is used, and very little cinder carrying water is spilt, the cost may be quite low. There is no value to the small amount of granulated cinder that is intercepted by fine screening. All costs connected therewith must be charged to operating expenses.

Miscellaneous wastes: As stated previously, the minor, and any special, wastes cannot be included in the discussion. However, in estimating waste treatment costs, a proportional allowance has been made, based on conditions found at several representative integrated plants.

Direct construction costs—This section deals with the initial construction costs of the various installations that would effect complete treatment of water-borne wastes. The figures are per ingot ton of steel-producing capacity and are based on the following assumptions (see Table VII).

1. General conditions are representative of integrated steel plants of one to four million ingot tons annual capacity with balanced distribution of different steelmaking facilities.

2. The treatment facilities correspond to what may be required to meet effluent quality standards currently being developed.

3. Inclusion of costs of all new construction, consisting of sewers, piping, water and power connections and necessary ancillary equipment, but not the cost of water or power production capacity and main distributors that may be required.

4. Direct costs of construction were estimated in accordance with 1957 prices. Engineering and supervision, but not administrative or financial charges or taxes, have been included.

5. Inclusion at 1957 replacement costs of any existing sewers, pumps or treatment units that can be utilized by the improved treatment project. This means that for any specific mill, actual construction costs will be reduced in proportion to the value of present installa-

TABLE VI

Representative Data on Cost of Treatment of Different Waste Materials (approximate range of costs including some allowance for required storage, piping, water and sewer facilities and based on other assumptions stated)

Flue dust	Multiple furnace plant (900–1200 tons per day furnaces)	Comprehensive facilities $150,000 to $350,000 per furnace		
		Primary scale pit	Secondary treatment	Combined installations
Mill scale and oils	Hot mills with effluent to be treated 2000 to 4000 gpm	$ 75,000 to $125,000	$150,000 to $250,000	$200,000 to $350,000
	Hot mills with effluent to be treated 8000 to 12,000 gpm	150,000 to 300,000	400,000 to 700,000	500,000 to 1,000,000
		Total cost of disposal per gallon	Acid regeneration plants various processes for integrated steel plant capacity	
Waste pickle liquor	Neutralization	1½ to 2½ cents	1,000,000 ingot tons—Probably not applicable 4,000,000 ingot tons—$1,250,000–$2,000,000	
Soluble oils	Small finishing mills or machine shop effluents	Flotation and sludge concentration plant $ 75,000 to $125,000		
	Large finishing mills	125,000 to 300,000		
		Dephenolizer	Secondary treatment	
Phenols	Coke plant for small integrated steel plant ((approximately 1,000,000 ingot tons annually)	$250,000 to $350,000	$100,000 to $250,000	
	Coke plant for large integrated steel plant (approximately 4,000,000 ingot tons annually)	500,000 to 700,000	250,000 to 600,000	
Granulated cinder	Multiple furnace plant (900 to 1200 tons per day furnaces)	Screening plant and related facilities $40,000 to $80,000 per furnace		

tions that can effectively remain in service.

6. Inclusion of cost of removal of a normal amount of the obstructions to the new installations, but not the cost of land used or of building any new facilities to replace the essential existing ones that may be physically displaced by the treatment units.

The lowest figures of Table VII (column 1) would apply where the effluent quality standards are not too strict, or to new plants where planning and construction is not handicapped by existing installations. Next would come the larger plants where space is available for the treatment works. The highest figures (column 2) would apply to smaller existing plants which are particularly crowded and where demolishments are necessary to make room for the wastes treatment units, and all construction must be executed without interruption of the production operations of the steel plant itself.

The estimated range of total construction cost is between $2.00 and $4.00 per ingot ton of annual capacity. In many cases, where some of the existing sewers, pumping and treatment units can be retained, only part of the indicated total cost will actually represent the amount of money required. However, there are cases where the existing facilities are inadequate or unadaptable, and better be completely replaced rather than trying to fit them into the new layout.

Direct operating charges—This section deals with the direct annual cost of wastes treatment. The figures are in dollars per ton of steel produced and are based on the following assumptions.

1. Conditions representative of integrated steel plants of one to four million ingot tons annual capacity with balanced distribution of different steel making facilities.

2. Inclusion of an allowance of 15 per cent for interest and amortization figured on the total construction cost of treatment facilities, as qualified by the respective assumptions listed in the previous section.

TABLE VII

Construction Cost of Comprehensive Water-Borne Wastes Treatment Facilities for a Representative Integrated Steel Mill (expressed in $ per ingot tons of plant capacity)

	Approximate cost range, $		Range in proportion of total, per cent	Representative	
	Lowest	Highest		Cost, $	Proportion of total, per cent
Flue dust	0.50	1.20	25–35	0.90	30
Mill scale	0.80	1.80	30–50	1.20	40
Acid	0.15	0.60	5–20	0.30	10
Soluble oils	0.05	0.12	2–4	0.09	3
Phenols	0.15	0.50	5–10	0.24	8
Granulated cinder (where required —not included in totals)	(0.00)	(0.12)	(0–5)	(0.09)	(3)
Miscellaneous	0.10	0.40	5–12	0.27	9
Totals				$3.00	100

TABLE VIII

Direct Operating Charges for Comprehensive Treatment of Water-Borne Wastes for a Representative Integrated Steel Mill (expressed in $ per ton of steel produced)

	Approximate cost range, $		Range, per cent	Representative	
	Lowest	Highest		Cost, $	Proportion, per cent
Fixed charges (interest and amortization)	0.30	0.65	65–80	0.50	73
Labor	0.05	0.10	5–15	0.08	12
Supplies, parts and maintenance	0.02	0.05	3–7	0.03	5
Power and water	0.02	0.05	3–7	0.03	5
Supervision and misc.	0.02	0.05	3–7	0.03	5
Totals				$0.67	100

3. Inclusion of all direct expenses such as supplies, replacement parts, also payment for water, power and labor used and for plant supervision, but not general administrative expenses or taxes.

4. No credit is included for the reclaim value of increased amounts of usable wastes products recovered. (Depending on conditions, this however may represent from 10 cents to 75 cents per ton of steel, or 10 to 90 per cent of the total charges for waste treatment and would correspondingly reduce the actual charge on the steel produced.)

5. Costs are based on steel production at about 80 per cent of the rated capacity of the plant. (Due to the relative importance of interest and amortization, the economic burden per ton of steel produced will notably increase if the steel production falls below that rate.)

Based on several cases studied and the above stated conditions, a typical breakdown of such direct charges per ton of steel produced (at 80 per cent rated capacity) may be as shown in Table VIII.

The direct operating charges can, in fact, range between $0.40 and $0.90 per ton of steel produced. Due to the higher percentage represented in these figures by the fixed charges, one of the most influential factors in costs is the degree of treatment desired, as this in turn determines the capital costs of the project.

The steeply increasing cost of removing a greater proportion of waste material remaining in the effluent is illustrated by Curve A on Figure 13. If the material is flue dust or mill scale, both of which have a reclaim value, the diminishing return effect of more complete treatment is shown by comparing Curves A and B.

The only waste substances that have an appreciable reclaim value are flue dust, mill scale and, potentially speaking, waste pickle liquor.

If one could credit against the total cost of complete treatment the full reclaim value of all such materials recovered, the net addition to the cost of producing steel, due to the treatment of wastes, would be reduced by more than 75 per cent. However, in most existing steel plants (where for example 85 to 90 per cent of the wet flue dust and 70 to 80 per cent of the mill scale is already being intercepted and utilized) only the value of the relatively smaller additional quantities of material recovered as a result of such complete treatment could be used to offset the corresponding new charges. This would mean reducing the charges only by 10 to 30 per cent.

Over-all capital requirements and operating charges: —For integrated steel plants, the total direct construction cost of complete new facilities for industrial wastes treatment, and for full recovery of the waste materials, were stated to range from $2.00 to $4.00 per ingot ton annual capacity, less the proportionate value of usable installations. At this point, one must take into account other related expenses, such as sanitary sewerage improvements, the value of the land occupied, the cost of providing power, water and other utilities, administrative charges, interim interest and miscellaneous financing costs and finally taxes. All these added items may, together, amount to 20 to 40 per cent of the above construction costs. Assuming the surcharge will be 25 per cent, the total capital requirements of a comprehensive waste control program will range from $2.50 to $5.00. It may, therefore, be said that wastes represent ¾ to 1½ per cent of the over-all cost of an integrated steel mill.

Because the proportion of fixed to total annual charges is over ⅔ of the total, the additional capital requirements listed above will increase the given figures by 10 to 25 per cent. It follows that overall fixed and operating charges will range between $0.50 and $1.10 per ton of steel produced. From this, one must deduct anywhere from $0.20 to $0.70 for the value of the reclaimed materials, depending on the factors specific to each mill as discussed above. The net charges for waste treatment and disposal might range from $0.20 to $0.80, or ¼ to 1 per cent, but more usually about ½ to ¾ per cent of the total cost of making steel.

The relative importance of the fixed charges has been noted. If a plant operates at a low capacity rate, the charge per ton of steel produced is correspondingly increased. This unfavorable effect is one of the reasons why waste treatment improvements are not advanced more readily.

Limitation of treatment costs—Assuming that the treatment of all water-borne wastes will become obligatory for most steel plants in the next few years, what can be done to keep to a minimum the economic burden this will represent to the industry? Following careful consideration of this aspect of the subject, and as a result of experience in the design of a number of steel plant waste treatment projects, the following recommendations are offered:

1. Continued, and if possible increased, cooperation with pollution control authorities, both with respect to exchange of information in improving treatment processes, and in helping evolve more definite and practical quality standards, which in turn will permit the improvement programs to move forward on a surer basis.

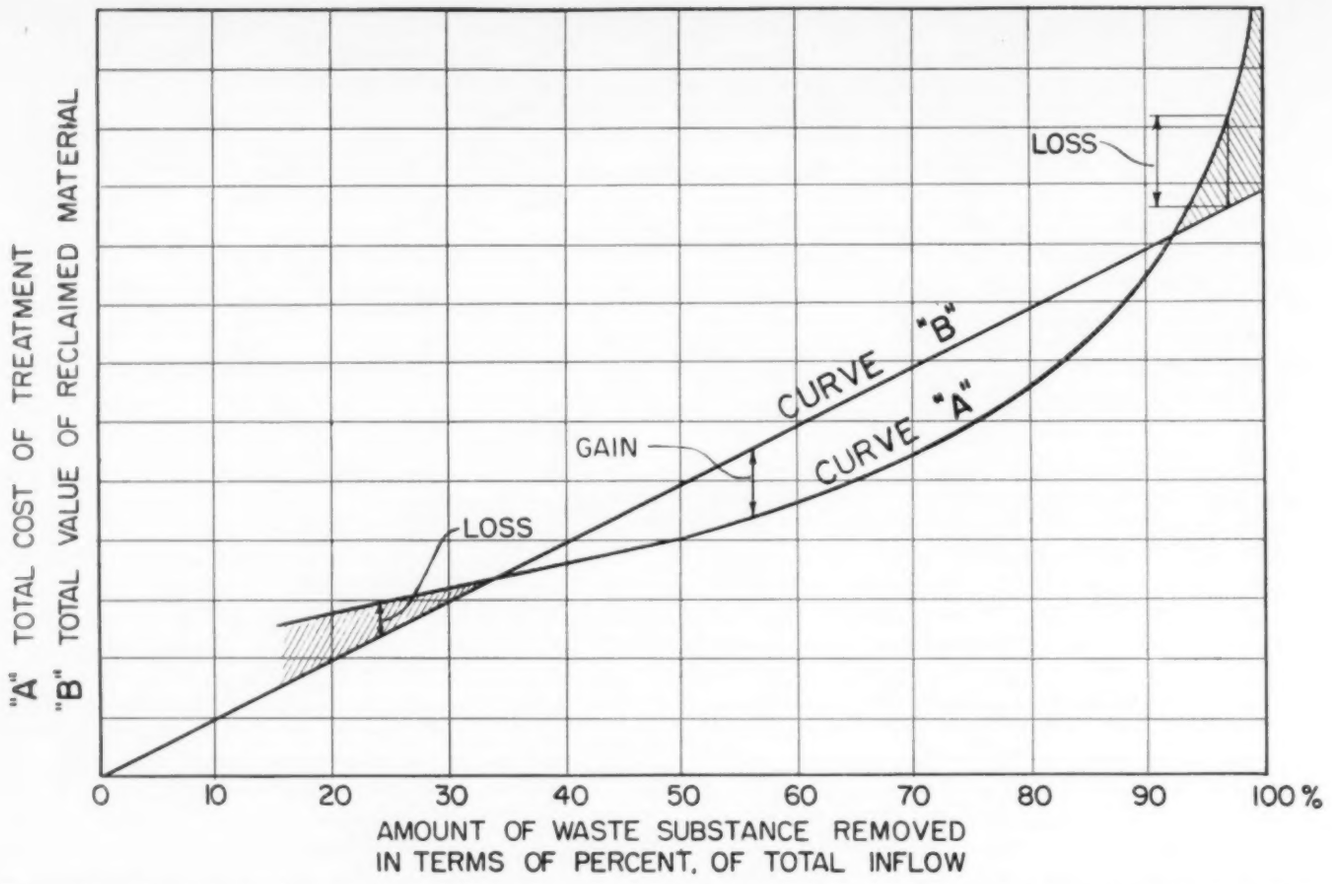


Figure 13 — Curves, which show relationship between waste treatment costs and value of recovered materials, tell the marked increase in costs which occurs when attempts are made to remove the final fractions. These curves are primarily applicable to flue dust and scale.

For example, any outright prohibition in some regulations of mixing different effluents after treatment with the cleaner nontreated discharges to lower wastes concentrations should be modified.

2. The carrying out of research projects by steel companies in their own, or in outside, laboratories. These to be directed to improving the known, and finding new, processes for the treatment of the various wastes substances, with special attention given to soluble oils, waste pickle liquor and phenols.

3. Encouragement of chemical process and equipment manufacturers to develop improved treatment techniques by testing their units and methods and releasing operational data on same, rather than allowing fragmentary information to filter through commercial channels.

4. Advisability of carrying out surveys at each plant to take an inventory of the wastes discharges, and of the existing installations dealing with them, as well as the study of the effluent quality regulations to be imposed. This will lead to advance planning of long term improvement programs. Among other benefits, such a procedure will permit decisions regarding sites for either waste treatment, or for further steel production facilities. The proper allocation of space in existing crowded plants creates the greatest engineering difficulties, but also offers the greatest opportunities for important overall capital savings.

5. When waste treatment facilities must be installed, detailed plans and specifications should be drawn up for the project so that adequate information is available for the preparation of proposals by equipment suppliers and construction contractors for the execution of the work under the most economical conditions.

DISCUSSION

PRESENTED BY

Dr. R. D. HOAK, Senior Fellow, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

ROSS NEBOLSINE, President, Hydrotechnic Corp., New York, N. Y.

L. A. FUGASSI, Assistant Chief Engineer, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

Dr. R. D. Hoak: The author has written an excellent review of waste-water treatment in the steel industry. His paper contains many practical suggestions, and his economic analysis of treatment methods should be particularly helpful to those planning installations.

In the section on recirculation, Mr. Nebolsine has pointed to the incongruity of prohibiting dilution of waste water to decrease the concentration of substances presumed to be deterious to water quality. In doing so he has touched upon the controversial issue of stream standards vs effluent standards.

It is generally agreed that the primary function of pollution control is maintenance of water quality appropriate for downstream uses. This necessarily means

that concentrations of certain constituents of waste water must, after thorough mixing with the receiving stream, be limited to selected maxima. Some regulatory agencies, in an effort to achieve this wholly proper aim, have established limiting concentrations of various substances in effluents without consideration of their ultimate concentrations in the receiving water. This procedure, from the agency standpoint, has the advantage of simplifying the administration of regulations, but it is quite irrational because it takes no account of the assimilative capacity of the receiving water.

It seems clear that, once there is a sound basis for setting a concentration limit for a given substance, the desired conditions can be attained by apportioning assimilative capacity through judicious restriction of the contributions by various users. Thus control of water quality can be achieved by establishing criteria for specific water uses; this is very different from depending solely upon arbitrary state-wide effluent standards.

A number of years ago, the Pennsylvania Department of Health, after exploring the subject with the steel industry, specified that no more than 25 per cent of the sulphuric acid purchased by the mills for pickling steel could be discharged as free and combined acid in rinse water. The city of Pittsburgh is installing a plant for primary treatment of domestic sewage. The Department has therefore halved the above figure (for Allegheny County alone) on the presumption that this would represent primary treatment of rinse water. Here is an illustration of the extreme to which an agency can be carried by a desire to be consistent at all costs. The volume of acid mine water flowing into the local rivers is so large that the new regulation will have an inappreciable effect on water quality, but the industry will nevertheless have to comply with it.

Treatment of raw coke oven gas with spent pickle liquor has the special advantage of making double use of the same acid: first for pickling, then for recovery of ammonia.

Careful study of data supplied by the Water Users Committee of the Ohio River Valley Water Sanitation Commission indicates that water purification plants in this area have no difficulty in handling phenol concentrations up to about 75 ppb. In this context, "phenol" represents the spectrum of phenolic substances measured by 4-aminoantipyrine. Difficulties do arise when high concentrations of phenolic material are permitted to flow to rivers as slug discharges.

Simple phenols are dissimilated rapidly (except at very low temperatures) in river water to which such material is customarily discharged. As phenolic molecules increase in size and complexity, however, the rate of biochemical destruction decreases. It has been demonstrated that much of the load of complex phenolic material derives from decaying vegetation. Unfortunately, these large molecules appear to be broken down by bacteria into smaller phenolic units which may, under certain conditions, cause medicinal odors in drinking water. Thus it is important to distinguish the relative effects of natural and industrial phenols as agents which cause tastes and odors.

Ross Nebolsine: The remarks of Dr. Hoak emphasize the complex nature of some of the problems faced by the scientists and engineers of the regulatory agencies. One must hope they will somehow find criteria that while protecting the public, do not demand more complete treatment than is justified when one takes all the factors into consideration.

L. A. Fugassi: Mr. Nebolsine's paper certainly reflects the many hours of study and research that must have been done to compile such a thorough and detailed report on "The Treatment of Water-Borne Wastes from Steel Plants." This problem is one of the most difficult facing today's modern steel plant.

Phenol, of course being one of the major offenders, requires the most attention.

Weirton has recently installed a counterflow centrifuge type dephenolizing plant and our operation gives approximately 98 per cent removal. One definite advantage is a compact plant which results in a definite space saving and the short length of downtime required to clean the centrifugal separators.

Another major source of waste, well defined by Mr. Nebolsine's article, is flue dust and we have installed a flue dust collecting system which pumps to two 80 ft diameter thickners where the sludge is removed as a cake from disk type filters.

A third waste which we have taken steps to combat is mill scale, especially from the hot strip mill. We installed hydraulic water sluicing equipment and collect the scale in a below-ground pit 20 ft 7⅞ in. wide, 75 ft 6 in. long, 22 ft 0 in. deep with approximately a 3½-hr rest period to permit the scale to settle out. Oil skimming and pumping facilities are also provided.

A fourth waste disposal problem is installed at our coal mine where we pump the coal washer waste water into a lagoon and thus permit clean effluent to overflow from the lagoon.

Also of importance is the segregation of sanitary wastes and we are now in the process of completing engineering for complete segregation throughout the plant.

Ross Nebolsine: Referring to the remarks of L. A. Fugassi, it will be noted that here is a good example of the execution, in stages, over a period of years, of modern waste treatment facilities for a large integrated steel mill.

At other plants, less time may be available for the completion of such a program. In these cases, comprehensive studies and plans, should preferably be prepared in advance, so that construction operations for taking care of the various wastes, can proceed in the manner that is best suited to the particular requirements of the situation.

Are you annoyed by having someone borrow your magazine when you want it? Get him to join the AISE.

Current Status

By WAYNE G. RITTER
Trabon Engineering Corp.
Pittsburgh, Pa.

▲ NO one in industry today disputes the great value of lubrication to the economical operation of his plant and equipment. In few instances can so much be returned for so little investment as the provision of some reliable means of regular lubrication of moving parts of machinery.

The steel industry has been a leader in improving lubrication practices in its plants. There is one particular piece of equipment, however, that has seemed to defy any attempts to provide it with adequate lubrication—the universal spindle coupling on rolling mills.

Should the simple flexible shaft coupling between drive and driven shaft be considered, lubrication in this instance is of great importance. The gear type coupling and the chain type coupling require lubrication, the lack of which leads to rapid wear on the contacting surfaces. In the case of the jaw-type coupling in which the jaws carry the load through nonmetallic load cushions, lubrication is unnecessary. Such jaw-type couplings allow for little angular or parallel misalinement. If this jaw-type coupling design is projected into the universal coupling, with the nonmetallic load cushions replaced with nonferrous metallic cushions, with angular misalinement in many cases reaching the magnitude of 12 degrees, it can be readily seen that lubrication is absolutely essential for satisfactory operation.

Improvement in slipper bearing materials has to some degree improved this situation. In the final analysis, proper lubrication to provide a constant lubricant film between the spindle head and slipper surfaces is the only way to realize maximum life from the slippers and to minimize the shocks to adjacent mill equipment caused by loose slippers in these couplings.

SCOPE OF THE PROBLEM

It is needless to point out to steel mill operators the magnitude of this problem. Almost all plants have slipper replacement costs itemized on repair and maintenance cost sheets. In typical steel plants in the Pittsburgh area, slipper replacement costs for metal alone would represent about 1 per cent of total repair and maintenance costs. It is not unusual for a hot strip mill to spend $75,000 per year for replacement slippers.

One steel plant in the Pittsburgh area spends about $9000 per year for slippers on the mill end of one bottom spindle! This is an extreme case on a reversing blooming mill but emphasizes the fact that a device capable of providing continuous lubrication to the slipper surfaces would effect considerable operating economies.

However, the cost of replacement slippers alone is only the cost of things easily seen and recorded. There are other resultant effects of worn slippers which will eventually show up on the maintenance cost sheet. Remachining costs on spindle heads are a considerable cost factor. Any repeated shocks occurring in a mill by reason of loose slippers, whether on a reversing mill or on an accelerating or decelerating unidirectional mill will promote metal fatigue of other components of the mill. Metal failures in piping systems, housings, line shafts and bearings can be attributed in some degree to this pounding caused by worn slippers. Modern reversing mills with direct-driven rolls will sustain damage to motor armatures if coupling slippers are worn. These are intangible costs, but like so many other costs resulting from improper lubrication, are considered by many mill operators to be expenses incurred in the normal operation of their plants. The slipper lubrication problem appears to be one that everyone talks about but, like Mark Twain's weather, nothing much is done about it.

LUBRICATION OF SLIPPERS

It is not the intent of this paper to ridicule any lubrication method now in use. Whatever methods are in use in some plants evidently are of some benefit or they would not be continued in use.

Perhaps the most common type of slipper lubrication is that of using high pressure hydraulic grease fittings on the slippers themselves. See Figure 1. When the mill is stopped, a manual grease gun is used to force lubricant into the interior of the slipper where grooves distribute lubricant to the pressure areas. The disadvantage of this method is that the mill must be stopped, and in order for the man with the gun to reach all points, the spindles must be either rotated or the man must climb around under them. This is a good method where every oiler is a conscientious employee, interested more in the saving of his company's money than he is in the cleanliness of his clothes or the wear and tear on his muscles.

Two plants in the Pittsburgh area have centralized these points by the use of a hydraulically interlocked feeder valve which positively divides whatever lubricant is introduced into its inlet into as many equal parts as there are grease ports. See Figure 2. The use of this method reduces the number of points on the two spindles shown from 32 to 4. It also proportions the lubricant so that all grease ports receive the same amount of lubricant. The grease fittings in the valve inlet are pointed both ways so that no matter in what position the spindle comes to rest, either of the fittings is accessible for a manual gun. Figure 2 illustrates the drive end of the spindle. On the mill end the feeder valve is mounted behind the spindle head and hoses closely attached and secured to the head to prevent the

# of Spindle Slipper Lubrication

. . . . a unitized spindle lubricator has been developed which can increase slipper life markedly on difficult applications . . . . lubrication is excellent, amount of lubricant is decreased, and cleanliness is obtained . . . .

adjacent spindle from rubbing them off. The hoses ordinarily are of smaller diameter than the grease fitting projection above the head. Where there is no clearance for hoses, the spindle heads have been drilled from the back of the head to intersect the transverse grease entry holes. This method of lubrication still depends upon a conscientious oiler, but because of the smaller number of points of lubrication to be served, usually in easy reach, the oiler may perhaps do a better job. This method is inexpensive, costing only a few dollars for the valve and hoses.

The idea of a rotating seal collar on the spindle body through which grease is introduced into a grease port in the fixed outside case and thence into the feeder valve shown in Figure 2 has challenged mill designers for several years. To date those which have been designed and tried have met with failure. This failure has come about through the inability of rotating shaft seals or packings to withstand the grease pressure required to force grease through the long ports into the interior of the spindle head. Should grease be introduced only when the spindle is at rest, the method may be workable if the proper packing design is used. A disadvantage of this method is the cost of the rotary seal collar. Except for short spindles without carriers, two would be required for each spindle unless a grease port were drilled under the bearing surface riding on the spindle carrier.

One steel company is now working on the rotating collar idea, but using oil laden air as the lubricating medium. No predictions should be made for this method before trial, but it can be said that the problem of rotating collar initial cost and maintenance cost is still evident regardless of the lubricating medium. If the seal can be maintained, and it should be more easily maintained with air pressure than with high pressure grease, the air may have a beneficial effect of keeping scale from getting between the surfaces of the slipper and the spindle jaws. Air is, however, quite hard to control once it emerges onto the slipper surfaces, and unless there is a considerable volume of air being used, the effectiveness of the purging action is questionable.

There have been designs for boots to contain oil in the spindle head. One rubber manufacturer is now working to perfect such a boot. These are similar in principle to the leather boot which was once wrapped around the universal joints on the drive shafts of automobiles. Such boots are expensive for the large spindles which present the biggest slipper problem. What to do during roll changes on the mill end boots is of course a problem with this method.

Figure 1 — Spindle slippers are lubricated through hydraulic grease fittings.

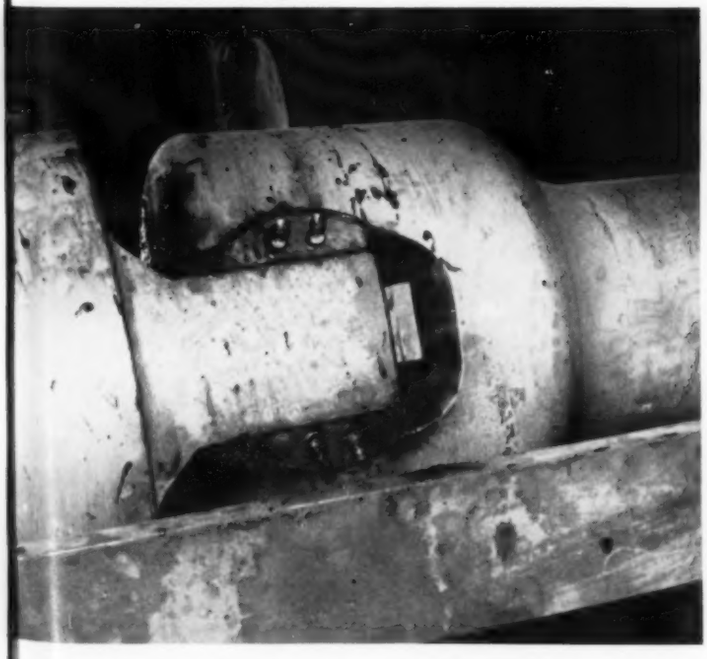


Figure 2 — Spindle slippers are lubricated from one central point.

There have been designs in the past which used a spring-loaded grease cylinder in the end of the spindle head. The idea of this method was to preload the grease cylinder which discharged grease slowly through ports into the slipper grooves by reason of the action of the preloaded spring. This method was but an enlargement of the spring loaded grease cup idea and, like it, had no control over rate of grease flow. Proper control of distribution of the lubricant over all the slipper surfaces was also not attainable.

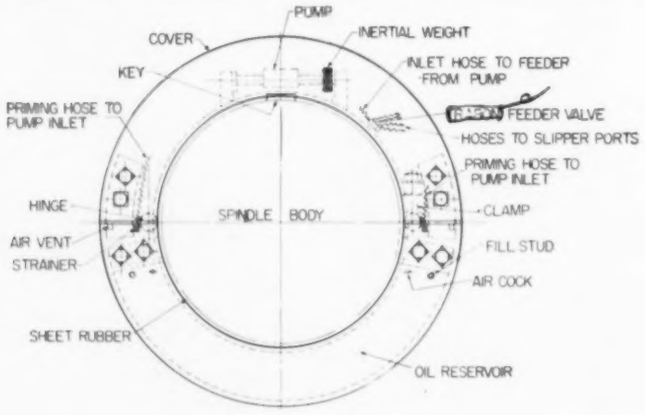
Now used in several mills in this country are the drop and spray methods. Both of these methods are like trying to get a drink of water out of a whirling lawn sprinkler. Introducing oil in this manner into the small clearances between the slippers and the spindle jaws from a point external to the spindle head presents an interesting problem in probabilities—the chance of dropping oil into a small clearance on to a rotating shaft with centrifugal force working against penetration once a hit has been scored. The chances, of course, are greater if the oil is sprayed. If efficiency, cleanliness and cost are disregarded these are workable methods.

A NEW IDEA—THE UNITIZED SPINDLE LUBRICATOR

The unitized spindle lubricator is a self-contained fully automatic mechanism which forces a predetermined amount of lubricant into the pressure areas of the slipper and which lubricant, by reason of centrifugal forces acting in the spindle, is spread along those slipper surfaces uniformly during mill operation. This mechanism and its components are shown on Figure 3.

The mechanism is in the form of a hollow cylinder of rectangular cross section split in two parts which fasten around the spindle in the manner of a yoke. Half of this cylinder is the lubricant reservoir having quick-connect fill studs approximately 180 degrees apart. No matter how the spindle comes to rest, lubricant can be pumped into the reservoir. The external lubricant supply hose is connected to the lower of the fill studs and the air cock adjacent to the opposite fill stud is opened to allow the air to escape which is displaced by the added lubricant. When lubricant shows at the air cock, the reservoir is filled. Under normal operation conditions, the reservoir full of lubricant is sufficient for two to six days of operation depending upon pump discharge rate.

Figure 3 — Components of unitized spindle lubricator.



An air vent is used to allow air to enter the reservoir as it displaces the lubricant which is pumped out into the slippers.

The pump consists of a pump body, a pumping piston, an inertial weight, inlet and outlet ports and an outlet check. The priming ports are connected to the lubricant reservoir by flexible hoses. The forces acting on the lubricant in the reservoir force lubricant through the priming hoses and keep the pump under a positive prime at all times while the spindle is in motion. The inertial weight on the pump is actuated, in the case of reversing mills, by the forces acting on it as the direction of rotation is changed. The weight acts directly on the pumping piston which in turn forces lubricant into the positive feeder valve. The pumping piston also acts as a shock absorber so that there is no pounding of the weight against a solid stop. The piston stroke is adjustable so that the rate of lubricant input to the slippers can be varied to achieve desired lubrication.

The lubricant from the pump is divided into any number of parts by a hydraulic feeder valve. This valve shown on Figure 2, proportions the lubricant positively, without relation to resistance to flow, into a number of parts equal to the number of inlet ports drilled into the spindle head for lubricant entry into the slipper pressure areas. The lead lines from the feeder valves to the entry ports are $\frac{3}{16}$ in. inside diameter high pressure, wire braid hose with high pressure reusable hose fittings.

The entire mechanism is covered by a third major component—the cover. The principal functions of the cover are to prevent physical damage from flying scrap or hot top material released from the ingots passing through the rolls and safety. Were it not for the cover, providing a smooth cylindrical surface, there would be protuberances which would create a hazard to personnel working near the spindles.

The inside surface of the lubricator is covered with a sheet of special rubber compound bonded to the metal. This prevents metal-to-metal contact with the spindle body and is essential to the successful holding of the lubricator to the spindle shaft. On most blooming or slabbing mills or on continuous mills, it is sufficient to key the lubricator to the spindle shaft, which, with the clamping action of the lubricator itself, holds it firmly in place. On very rugged mills, it may be advisable to fasten to the spindle head in addition to clamping.

Because of the adjustability feature of the pump, the heavy oil in the reservoir can be positively distributed in small quantities over the slipper surfaces regularly applied in relation to the amount of work the mill is doing.

For field test, this unitized spindle lubricator was installed on the mill end of the bottom spindle of a very hard working blooming mill in the Pittsburgh area. This blooming mill is a 44-in., two-high reversing unit with steel rolls of 43-in. collar diameter and 90½ in. body length, running in babbitted bearings. Roll lift speed ranges up to 50 fpm. The mill is driven by four 3000-hp, 70 to 140-rpm, 750-volt, d-c motors arranged in tandem twin drive. Each roll is driven thru a 21-in. diameter spindle, 19 ft-7 in. long. The drive has a rated full load torque of 2,020,000 ft-lb at 80 rpm. The rolls can be accelerated from 0 to 80 rpm in 0.9 second. The mill rolls at speeds up to 1350 fpm and averages about 225 net tons per hour. The mill has rolled as much as

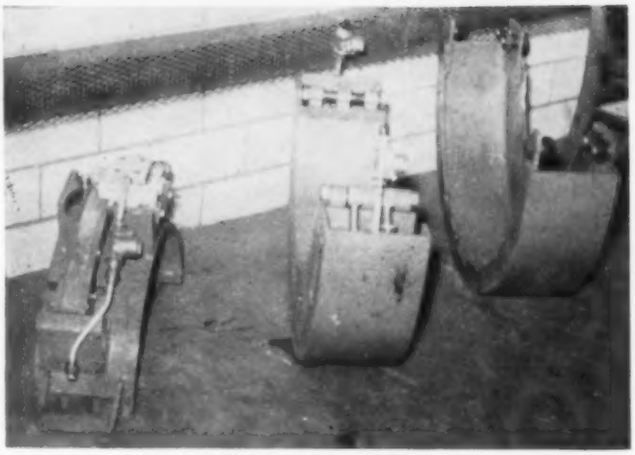


Figure 4 — Original spindle lubricator test unit was first put on a 44-in. bloomer.

335 tons per hour, 2562 tons per 8-hour turn. When it is realized that a record tonnage was rolled in 526 ingots in one 8-hour turn, some conception can be had of the extremely rugged operating conditions under which the slippers operate. Such a mill provided a good laboratory for experiment.

The original spindle lubricator installed on this mill is shown on Figure 4. The lubricator is shown in its three component assemblies; the pump section, the reservoir section and the cover. The metallic priming tubes were replaced with hoses shortly after being put into operation. The lubricator was pinned to the spindle shaft using a $1\frac{7}{8}$-in. diameter alloy steel pin, 3 in. long, $1\frac{1}{2}$ in. in the spindle and $1\frac{1}{2}$ in. in the lubricator. The feeder valve was fastened to the outside of the cover in a position near the pump. Four $\frac{3}{16}$-in. inside diameter hoses connected the outlets to the four bearing ports. Figure 5 shows the approximate location of the drillings in the spindle head. In this position the feeder and the hoses were exposed to physical damage which did occur. This was expected since the test was to prove the soundness of the lubrication principle and to test strength of materials. Hoses were replaced twice in a 5-month test run, the feeder was replaced once after having been hit by flying scrap. The inertial cam in the test model oscillated in a race-way providing a movement of about 2 in. which was sufficient to actuate the cam follower on the pumping piston. The model now being readied for installation does not make use of a rolling inertial cam but an inertial weight directly on the pumping piston.

The lubricant had the following specifications:

Pour point	5 F
Color	Black
Flash point	460 F
VI	90
Viscosity	1755 ssu @ 100 F 115 ssu @ 210 F
Timken	50 minimum

Compounded with $7\frac{1}{2}$ per cent lead naphthanate and with rust, oxidation and foaming inhibitors.

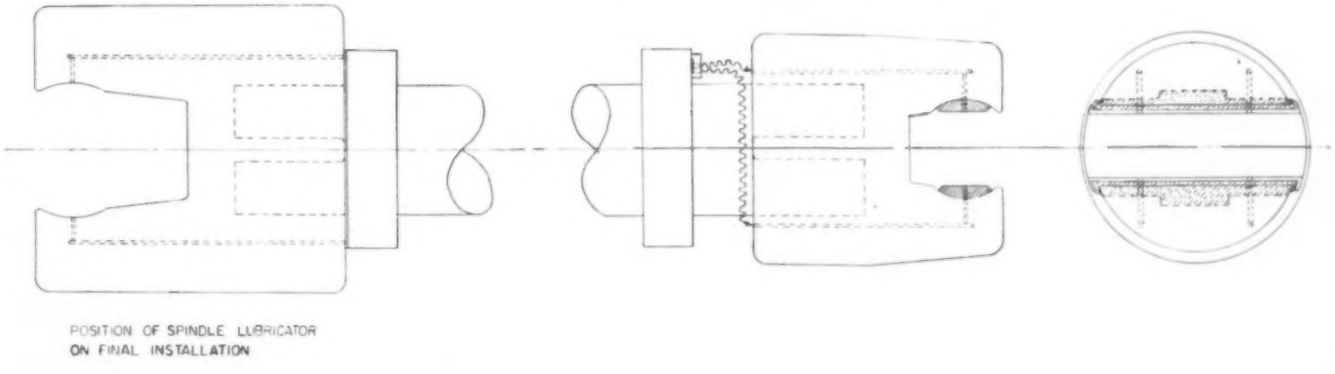
The field test of the spindle lubricator was of five months duration. During that period observations were made not only on mechanical design of the lubricator itself but, more important, the effect of continuous lubrication on slipper life. Observations on mechanical design have been used to strengthen and change the design of the lubricator now being readied for installation. Observations of effect on slipper life were as follows:

1. Slipper life was doubled. On this particular mill the tonnage rolled per slipper set on the mill end, bottom spindle was increased from about 125,000 tons to 250,000 tons. It was anticipated that the life would be tripled on the next installation.
2. The lubricant distribution pattern was excellent, being uniform over all wearing surfaces.
3. There was a considerable reduction in the amount of lubricant used in the lubricator as compared to the method of pouring dippers full of lubricant over the spindle head when the mill was idle.
4. There was a noticeable improvement in cleanliness in areas adjacent to the spindle head as a result of less lubricant being used, and being added internally rather than externally to the spindle head. Should the unitized spindle lubricator be used on all four spindle heads of the mill, the improvement in appearance and the lessening of safety hazards to men working around the spindles would be of significant consideration.
5. Decreased rate of slipper wear had a corresponding decrease in the shocks transmitted to bearings, housings, piping, etc., caused by loose slippers.

SUMMARY

The method of centralizing lubrication points on spindle heads by use of a feeder valve as shown in Figure 2 is beneficial for mills which do not have excessive slipper wear. This method attacks a human

Figure 5 — Arrangement of spindle head lubricator and spindle head drilling.



problem and as such does increase slipper life with resultant cost savings.

The unitized spindle lubricator has been tried on a mill considered to be representative of the most severe conditions to be encountered in the steel industry. Its design principles appear to be sound, and because of its rugged design can be adapted to any slabbing or blooming mill spindle.

A spindle lubricator for unidirectional mills differs from the type discussed in this paper only in the means of actuating the lubricator pump. This design has been developed.

Whatever mechanical method of lubricating spindle slippers is used, it must be realized that, like any equipment used in the steel industry, continuous inspection and maintenance must be carried out.

DISCUSSION

PRESENTED BY

WAYNE G. RITTER, Trabon Engineering Corp., Pittsburgh, Pa.

S. C. READ, Director of Construction and Maintenance, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

H. F. JACQUART, Plant Engineer, Washburn Wire Co., Phillipsdale, R. I.

CHARLES H. GOOD, JR., Assistant to Vice President Operations—Steel, United States Steel Corp., Pittsburgh, Pa.

FRED H. PADDON, Sales Engineer, E. W. Bliss Co., Rolling Mill Div., Salem, Ohio

R. J. SCOVILL, Assistant Division Superintendent Central Mills, Gary Steel Works, United States Steel Corp., Gary, Ind.

LARRY J. HOFFMANN, Superintendent Mechanical Maintenance, Germany Works, Lone Star Steel Co., Lone Star, Texas

Member: I would like to know in this installation if they had ragging on the rolls, and what clearance they have between the brass and the spade? How great is this clearance when they consider a set of brass is worn?

Wayne G. Ritter: May I refer this question to Mr. Read?

S. C. Read: You ask about permissible slipper wear. In my experience with blooming mill maintenance and operation, I have found that slipper wear of $\frac{5}{16}$ in. or greater may result in either spindle or pinion breakage. I have checked the practice at several strip mills to determine their practice and have been advised that $\frac{5}{16}$ in. wear is too great, especially when the mill is scheduled to roll wide product.

We know that slipper wear begins as soon as they are put into operation. For maintenance economy, it is desirable to minimize wear, thereby extending slipper life. Maintenance people are constantly seeking a better slipper material. Mr. Ritter's development of an improved method of slipper lubrication is also a step toward prolonging slipper life and should have applications in both blooming and strip mills.

It would be interesting if someone from other plants would state his views on slipper wear tolerances.

H. F. Jacquart: We run around $\frac{1}{8}$ in. We consider that rather bad sometimes.

It used to be the master mechanic in that 48-in. reversing bloomer mill. Procedure depended on what you were rolling, the grade, drafts being taken and other factors which would change the specification. If you are rolling a product that is a very high alloy where you have a tendency to have trouble with your roll biting material, you must keep that wear down to the specification Mr. Read talked about. About a $\frac{1}{4}$ in. is the right total clearance. The thing that breaks the heads is the backlash you get when the product is not biting in the rolls. I think that would change in almost every installation.

S. C. Read: I will add one more word to that. You know some of us who are oldtimers go back fifteen to thirty years in steel mill operations. We would see in the blooming mill an oiler with a can. His job was to take the can out and pour it on the slippers when there was a stoppage and hope that would last until such time as he could lubricate it again. Also going back, at least twenty years, if you could stick your little finger in between a slipper and a head at your total clearance, you were headed for trouble.

You do have to recognize that just as soon as you put a slipper in, wear begins, and you cannot, from the time you put a new one in to the end, always have an ideal clearance. There is some risk taken, and of course, you want to find out how far wear can be permitted.

I go back again to Mr. Ritter's problem. I happen to know he is developing equipment along successful lines. When that is completed there is hardly a man in the steel mill who will not get benefits.

Member: We now use a boot, rubber boot. Prior to that we got about 200,000 tons. We hope to do better with the boot on it.

Charles H. Good, Jr.: What type mill is that?

Member: A 40-in. bloomer.

Fred H. Paddon: I would like to ask a pertinent question as we seem to have representatives here that are very familiar with the slipper maintenance problems. On the various type mills, say a 42-in. blooming mill, hot mill or rod mill, what do you consider good life of slippers per your experience?

H. F. Jacquart: Years ago we started with an idea similar to Mr. Ritter's except we relied completely on centrifugal force. We welded a conical shaped can to the head itself, and drilled through the head into the slipper fit, similar to Mr. Ritter's application. Mr. Read will remember this very well. It was all right except that you got about five gallons in the can, the same amount Mr. Ritter is putting in this one, but you had no way of distributing it proportionately. So over a period of a turn, you would take one five-minute stop to fill your can on both top and bottom spindle, then you had lubrication for approximately five or six hours. As he mentioned, it was a terrific housecleaning problem, throwing oil all over everything. So over the years we got away from putting such a unit on. This is a problem I think, in the Aliquippa mill application, is it not?

Wayne G. Ritter: The reservoir is emptied over a longer period of time because the flow rate is controlled.

H. F. Jacquart: It was started at Pittsburgh, taken to Aliquippa where they have made some progress with it that I am unfamiliar with.

S. C. Read: I visit every steel mill in the East, and whenever I am in a blooming mill or strip mill, I have asked that question "How much wear do you permit on slippers?" I have been trying to find a real answer. I get all kinds of answers. I wonder. In fact, someone told me, "Oh, we never permit a tolerance of over ½ in." Well, in most of the blooming mills that would be pretty expensive, I think.

R. J. Scovill: We allow up to approximately ¼ in. of play in our 44-in. blooming mill spindle slippers. Has anyone tried hard surfacing the spindle where it contacts the slippers and with what success?

H. F. Jacquart: Yes, years ago we shortened our slipper surfaces. It set up stresses that we thought were detrimental to the life of the spindle itself.

S. C. Read: I have tried nearly every alloy you could probably think of for slippers, and they all get wear.

Larry J. Hoffmann: I am like Mr. Read, from the era when you used to pour oil on slippers. Back in about 1926 that was the only method I had ever seen. We used to stop our mill then and oil the slippers every two hours. Maybe I am wrong, but I believe we did about as good a job of lubrication then as the average installation today. Perhaps some grease installations are better.

Several years ago, I became acquainted with Mr. Ritter's idea for lubricating slippers and I had hoped to come to this meeting to find this method in wider usage and to learn more about it. It seems, however, that extreme difficulties are encountered in its application. In the discussion no one has mentioned the wear on the spindle which I believe to be a more costly problem. At least this is where I have encountered the most trouble. Due to the difficulty of covering all surfaces, I was interested in the lubrication points which Mr. Ritter mentioned and which he stated the points of greatest stress. It appears to me that these points are probably the origin of the forces which tend to flow the lubricant outward and this should aid lubrication.

I, too, have some questions to ask the group. Recently I had some experience with molybdenum disulfide greases. I wonder if anyone here has tried this grease on their slippers. I have not had enough experience to have any convictions about it to date.

Years ago I had experience in trying out steel slippers with bronze coating and the amazing thing to me was that although they were stress relieved after coating, these slippers warped in service. How that happened, I do not know but they did and the experiment was abondoned as a bad job.

I am interested in hearing other people's problems in type of grease used and also in the materials. For example, I have heard the relative merits of phosphorous and aluminum bronze discussed many times and I wonder if anyone here has any opinions along those lines.

Member: I do not have an answer to that question, but I do have another question I would like to pose to Mr. Ritter, please. I can see how the lubricant can be pumped to the surfaces between the jaw half coupling and the slipper, but how is the oil forced through the slipper to the surface between the spade and the slipper, especially when angularity varies?

Wayne G. Ritter: In Figure 5 in the right view of the test installation, the drilling in the spindle head lines up with the lubrication hole in the slipper. The slipper drilling is a hole of larger diameter than the mating hole in the spindle head. When the lubricant is discharged under pressure into this area, there is a 50-50 chance of it going either on the surface between the slipper and the spindle head or between the slipper and the spade. Observation of the surfaces during the five months test run showed that all surfaces had adequate oil films which appeared to bear out the above expectation.

Member: As I understand this mechanism was put on a bottom spindle. I am curious to know what would happen if it were on the vibrating spindle whereby your slippers rotate inside the jaw half coupling.

Wayne G. Ritter: This mechanism was put on the bottom spindle, mill end, because this location was, on this particular mill the point where most excessive slipper wear was taking place. The wear was excessive here because of the contaminating materials which continuously fell into the surfaces inside the coupling. Even though the top spindle coupling drives under great angularities, wear is never as bad as on the bottom spindle. It is anticipated that when this mechanism is installed on the top spindle, that the pump discharge rate will be about one-half or one-third that pumped by the bottom lubricator.

Member: If there is any angularity, your slippers will rotate slightly in the jaws, therefore your holes will not aline, you will still get grease between the surface of the jaw and the slipper, but I do not believe it would be forced between the slipper and the spade.

Mr. Ritter: As mentioned previously, the lubricant drilling in the slipper is large enough to take care of misalinement during changes in angularity. It may be necessary to compensate even more when the unit is installed on the top spindle. That question will certainly be studied before any installation on the top spindle is made. Another thing to bear in mind is that we are not working with noncontrolled oil flow. There is a positive discharge of oil under pressure, which is checked at the feeder valve. Considerable hydraulic pressure is developed by the pump to get the oil into the wear areas. By using heavy, extreme pressure type oil there are inertial forces at work which tend to distribute the oil over the wearing surfaces.

In conclusion, the problems here appear to be physical. The principle has been shown to be sound. The physical problems can be worked out as is usually done in mill equipment design. Does the end justify these means? This is a problem which for years has caused havoc to mill equipment. The end, most certainly, is worth almost any effort to achieve. The company with whom we have been working on this problem has not condemned the effort before it began. To them our thanks.

New Trends in Firing Practices for open hearths

By JAMES E. GOODIN
Practice Engineer
Open Hearth Dept.
Granite City Steel Co.
Granite City, Ill.

. . . . paper presented at Chicago Regional Technical Meeting of American Iron and Steel Institute, October 16, 1957 . . . .

▲ IN the most competitive steel market in the history of the industry, we must all make the best possible use of equipment. One case in point is the firing of furnaces. As steel producers, we should take advantage of every opportunity to improve our practices in order to produce ingots at the lowest possible costs, particularly when fuel is considered. The time has arrived when technical personnel should emphasize to the operating people the desirability of firing furnaces at maximum fuel rates. We must, at all times, be on the lookout for new ideas that will improve and speed up our process.

With the above in mind, we at Granite City Steel started in June 1954 on an experimental program using high pressure natural gas to replace steam as the atomizing agent on our furnaces. Our shop consists of four 250-ton and three 285-ton furnaces. One of our larger (285-ton) furnaces was chosen for this project. This furnace was equipped with a 7 x 7 single stage, double acting, booster compressor, driven by a 75-hp motor, capable of delivering 50,000 cfhr at 250 psig, with an inlet pressure approximating 90 psig. The compressor cylinders were water-cooled.

From the compressor, the gas was sent through a 24-in. diam by 12-ft long receiver from which it was piped to the superheater installed in the stack flue. Valves are provided so that either steam at 160 psi on natural gas at 250 psi may be sent through the superheater. This was done to keep costs at a minimum and also to make it a simple operation to change from gas to steam as the atomizing agent when necessary maintenance had to be performed on the compressor or when gas was interrupted by extreme cold weather, at which time the gas company could not furnish gas.

The gas compressor, with its driving motor and receiver, was installed outdoors, adjacent to the open hearth building. There were, in addition to the normal three-step control of the compressor, a number of safety control devices. The compressor motor itself was equipped with the usual overload protection. There was provided in the inlet line to the compressor, a pressure switch which stopped the motor when the suction pressure dropped below 90-psi inlet pressure. This pressure, incidentally, was available from the transmission lines of the natural gas supplier. There was, in the discharge side of the compressor, a second pressure switch which stopped the compressor motor when the discharge pressure rose to too high a value. The three-step compressor control would normally vent this. The inlet line to the compressor contained a grease-lubricated plug valve for isolation purposes. Following the plug valve, there was a double ported diaphragm control valve capable of tight shutoff and arranged for air pressure opening and spring closing. General service compressed air lines supplied air loading to the diaphragm of this valve. Connected between the orifice and diaphragm there was installed a magnetic valve which closed when energized and vented the air loading pressure on the diaphragm control valve through a port to the atmosphere when de-energized. This solenoid valve opened under emergency conditions whereupon the diaphragm valve would close.

There were start and stop pushbuttons of explosion-proof design mounted on the box which contained the pressure switches, three-way valves, etc., which comprised the three-step compressor control. There was mounted beside the motor starter, and both located inside the building, an auxiliary panel containing the pressure switches which stop the compressor at low inlet or high discharge pressure, the solenoid valve which controls the emergency shutoff valve in the inlet line, a relay and a push button to reset the emergency shutoff valve.

There was mounted on the panel, which carried the combustion control apparatus and furnace instruments on the charging floor, an emergency stop button of the large palm type. There was also located on the outside wall of the building directly over the compressor a so-called detect a fire device which opened a control circuit when the ambient temperature reached 225 F. Depressing the emergency stop button on the control panel or opening of the fire contacts caused a relay to open. This relay could be reclosed by the gas valve reset button, mentioned above, provided the emergency stop button was not held down and provided the contacts in the device were again closed. Opening of this relay caused the main compressor motor to stop and the emergency gas valve to close. There was, furthermore, a thermostat provided in the outlet water

from the jackets of the compressor which opened its contacts upon excess water temperature and shut down the compressor motor.

The main gas supply to the compressor was an overhead line and there was provided, at the point where it came out of the ground from its underground connection, a high pressure gate valve. Its location was made sufficiently remote from the compressor to be accessible even in the event of an uncontrolled fire at the compressor. There was provided, at the gas company's metering station several hundred feet away, an adequate safety valve to prevent the inlet header to the compressor from reaching abnormally high pressures. A safety valve, with relieving capacity slightly more than that of the compressor, was located on the receiver. There were no valves between the compressor cylinder and the receiver. There was a safety valve of comparatively small rating on the superheater outlet header, which prevented the superheater from reaching dangerous pressures in the event that the steam inlet valve, gas inlet valve and gas outlet valve were all three tightly closed. In the event of a superheater leak, it would have been necessary to go to steam atomization by by-passing steam around the superheater.

For several months, the experimental program on the furnace was carried on by alternating steam and gas on a schedule of steam one week and gas the next week. Close observation was maintained on the furnace, comparing flame characteristics, melting rate, costs, etc. Even though costs per ton of steel produced were lower, due to the greater use of the cheaper fuel, the heat time at first did not improve to any great extent when using high pressure instead of steam. The firing rates used during this interval were as shown in Table I.

TABLE I

	Melt down	After hot metal	Refining
Air, cfm	16,500	16,500	15,000
Oil, gphr	400	350	300
Gas, cfhr	50,000	50,000	50,000
Furnace pressure	0.075	0.075	0.075
Reversal cycle, minutes	12	12	12

The first campaign was run from June 18 to August 10, getting 100 heats on the roof. The overall shop average was 143 heats per roof. Flame characteristics were fair, but had a tendency to float to the roof.

In January 1955, using natural gas as the atomizing agent continuously, we began to experiment with higher furnace pressures, maximum air input and shorter reversal cycles. During this period, we established a firing schedule as shown in Table II.

TABLE II

	Meltdown	After metal	Refining
Air, cfm	25,000	25,000	25,000
Oil, gphr	350	300	275
Gas, cfhr	50,000	50,000	50,000
Furnace pressure	0.15	0.15	0.15
Reversal cycle, minutes	6	6	3½

This was approximately 120,000,000 Btu an hour input when melting down. Excess oxygen varied between three and five per cent. During the very late stages of the heat, just prior to tapping, first helpers reduced air input very slightly.

With the increased furnace pressure, we now had a shorter, sharper flame that we could control readily, keeping it away from the roof, and one that would melt scrap very rapidly. We feel that the maximum input of air and short reversal cycles helped to control roof temperatures to a safe value. As long as we used maximum air and short reversal cycles, the roof did not get dangerously hot.

Immediately upon applying the above operations on this furnace, the tons per hour began to increase. The first 39 heats tapped were logged very completely on every phase of operation. The average tons per hour were 23.19 with a low heat of 19.14 and a high of 29.61 tons per hour.

Our shortest heat time during this period was 9 hours 50 minutes from tap-to-tap with one hour daily between heats.

After two months of successful operation on this furnace, it was decided to go ahead with the program and equip all furnaces with individual compressors. It was decided that the three large furnaces would be equipped with compressors capable of delivering 65,000 cfhr and continue with 50,000 cfhr for the four smaller furnaces.

TABLE III
Compressors

250-ton furnaces	285-ton furnaces
Size—7 x 9	Size—8 x 11
Maximum pressure—250 psig	Maximum pressure—250 psig
Rpm—360	Rpm—300
Induction motor	Induction motor
75-hp 1760 rpm	100-hp 1170 rpm

Installation was completed on all furnaces on September 9, 1955.

Although the compressors provide 250-psig discharge, we are getting only 210 psig at the burner due to pressure drop across numerous valves and small interconnecting piping. We are now in the process of enlarging the piping on one furnace to allow us to secure higher pressure and increased volume at the burner.

It was encouraging to note that we raised tonnage and reduced fuel input. The records show that in a little over 18 months prior to January 1, 1956, tonnage had increased from 17.1 tons per hour to 20.5, with a drop in Btu's per ton from 4.1 MM to 3.6. This was accomplished using an average of 38 per cent hot metal.

During most of the year 1956, due to the building of a new and larger blast furnace, the shop was operated on a very low percentage of hot metal (small furnaces approximately 12 per cent—large furnaces approximately 25 per cent). Since September 1, we have raised the hot metal percentage to 40 per cent and have had some very good, but still inconsistent, results. The highest tons per hour during the last few months was 34.71 from the large furnaces and 26.40 tons per hour from the small furnaces.

At Granite City Steel Co., we believe that high pressure gas as an atomizing agent can be used efficiently to replace steam. The current prices of natural gas and fuel oil also make a high pressure gas for atomization economically attractive. Still more favorable results are anticipated as we continue this process.

TENTATIVE PROGRAM

AISE Western Meeting

STATLER HOTEL LOS ANGELES, CALIFORNIA

February 24, 25, 26, 1958

MONDAY, FEBRUARY 24

8:30 am—REGISTRATION

9:00 am—TECHNICAL SESSION—SIERRA ROOM

Chairman: Ruben Finkelstein, Vice-President, Southwest Steel Rolling Mills, Inc., Los Angeles, Calif.

Louis E. Ringger, General Supervisor, Electrical Engineering, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah

"Automatic Numerical Data Logging and Processing in the Steel Industry," by R. M. Sills and G. E. Terwilliger, Steel Mill Engineering, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

"Static Control Provides Blast Furnace Automation," by Neal J. Behne, Electrical Engineer, Ohio Works, United States Steel Corp., Youngstown, Ohio; H. C. Diener, Jr., General Purpose Control Engineering Dept., Westinghouse Electric Corp., Buffalo, N. Y.; and J. Raymond Erbe, Metal Working Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

"A New Conception in Crane Control," by Charles W. Zwiefel, Chief Engineer, Pacific Coast Engineering Co., Alameda, Calif.

2:00 pm—TECHNICAL SESSION—Sierra Room

Chairmen: W. E. Harris, Plant Engineer, Consolidated Western Steel Div., United States Steel Corp., Provo, Utah

W. H. Kinney, Assistant to Vice President of Operations, Kaiser Steel Corp., Oakland, Calif.

"Allegheny Ludlum Steel Corp.'s New Forge Shop, Dunkirk, N. Y.," by Emil Kern, Vice President in Charge of Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa., and James E. Trabits, Plant Engineer, Allegheny Ludlum Steel Corp., Dunkirk, N. Y.

"The Modern Forging Press and Its Control," by Otto Hoffmann, Vice President—Engineering, and Alex Krynytzky, Supervisor, Mechanical Engineering, Lake Erie Machinery Corp., Buffalo, N. Y.

"Some Heavy Industrial Noise Problems, Their Analyses and Solutions," by Richard D. Lemmerman, Manager, and Richard R. Audette, Assistant Chief Engineer, Industrial Sound Control Dept., Koppers Co., Inc., Baltimore, Md.

"Ten Painting 'Reminders' for Steel Plants," by Walter T. Yarhouse, Industrial Sales Representative, The Sherwin-Williams Co., Cleveland, Ohio

TUESDAY, FEBRUARY 25

9:00 am—TECHNICAL SESSION—Sierra Room

Chairmen: G. W. Teskey, Jr., Superintendent Open Hearth, Bethlehem Pacific Coast Steel Corp., San Francisco, Calif.

Ernest F. Donatic, General Superintendent, Kaiser Steel Corp., Fontana, Calif.

"Immersion Thermocouple Practice," by H. V. Schubert, Fuel Engineer, Seattle Plant, Bethlehem Pacific Coast Steel Corp., Seattle, Wash.

"Continuous Annealing 60 Tons per Hour of Tinplate," by Quentin M. Bloom, Manager, Furnace and Kiln Div., Selas Corporation of America, Dresher, Pa.

"Safeguarding Steel Production," by R. M. L. Russell, Assistant Chief Engineer, Factory Insurance Association, Hartford, Conn.

2:00 pm—TECHNICAL SESSION—Sierra Room

Chairmen: William Brill, Director of Engineering, The Colorado Fuel and Iron Corp., Pueblo, Colo.

R. L. Dowell, Assistant to General Superintendent, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

"Thermit Welding Structural Mill Rolls," by Edward B. Russell, Assistant to Superintendent, Mechanical Shops, Kaiser Steel Corp., Fontana, Calif.

"High Speed Sheet Temper Mills," by D. E. Rea, Electrical Application Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

"Rolling of Metals," by Joseph I. Greenberger, Group Engineer, United Engineering and Foundry Co., Pittsburgh, Pa.

"Mechanical Maintenance in the Pueblo Plant of The Colorado Fuel and Iron Corporation," by Jerome L. Lindberg, Assistant to the Director of Mechanical Maintenance, The Colorado Fuel and Iron Corp., Pueblo, Colo.

7:00 pm—INFORMAL STAG DINNER—Pacific Ball Room

WEDNESDAY, FEBRUARY 26

Inspection Trip

hotel reservations

Write direct for hotel reservations to Hotel Statler, Los Angeles, Calif., giving time of arrival and type of accommodations desired. Reservations should state that they are for AISE Western Meeting.

transportation

Individuals or groups desiring assistance in planning their trip should get in touch with the office of American Express Company in their respective cities, or with any local travel agency.

Figure 1 — Aerial view shows plant before installation of 13-in. mill.

A Modern Rod and Merchant Mill

By W. R. POTTS, Chief Engineer
and R. M. LANG, Rolling Mill Superintendent, Atlantic Steel Co., Atlanta, Ga.

. . . . paper presented at Birmingham Regional Technical Meeting of American Iron and Steel Institute, October 23, 1957 and AISE Birmingham District Section Meeting, October 26, 1957 . . . .

▲ SOME 50-odd years ago, Atlantic Steel Co. was located in a wilderness on the northwest outskirts of Atlanta. Today the entire plant is well within the city limits of Atlanta and consequently, when the company desires to make plant additions, serious thought must be given to the layout in order to conserve and make best use of the very limited acreage available (Figure 1).

The combination rod and merchant mill presented here is the end result of many conferences between executives, operating and maintenance people, roll designers and plant engineers. Once the ranges of products to be produced by the mill were settled, the physical layout and the location of the mill became major items.

For the design and layout of the mill, we asked four of the well known mill builders to present layouts. After many conferences with these mill builders and many layout revisions, a company was selected to design and build the mill. This was the same company which some 50 years ago had sold Atlantic Steel Co. the combination mill that has been our bread-and-butter producer up to the present time.

LAYOUT AND DESIGN

We soon found that the space requirements for the proposed mill were such that it would be practically impossible to tear out the old mill and place the new mill in the old mill's location, Figure 2. Eventually the area just east of the maintenance shops was selected as the location of the combination rod and merchant mill, Figure 3. This selection of location we feel was the best in spite of the extra costs involved. These extra costs included buildings, utilities and blasting of hard rock. Unfortunately, this rock proved to be much harder

Figure 2 — Location of old rod and merchant mill was too small for new mill.

to move than the studies of the soil engineers had indicated.

Layouts of the mill indicated a mill building 100 ft wide and 740 ft long to house the mill proper. Cooling bed products from the mill are processed in a warehouse building 200 ft wide and 260 ft long, which lies perpendicular to the mill building. This warehouse building is located at the south end of the mill building. See Figure 4.

The mill and warehouse buildings were designed to the following general specifications:

Mill type construction, 34 ft-6 in. to bottom chord, 26 ft. to overhead traveling crane rail.
Foundation concrete—2500 psi.
Floor concrete—3000 psi.
Twenty-two gage roofing.
Twenty-four gage siding.
Industrial type corrulux roof panels.
Open type monitor running full length of building, Figure 5.

The motor room was constructed of Jumbo masonry brick walls to the bottom of the roof truss and has standard structural steel framing and 22 gage corrugated metal roofing with industrial type corrulux roof panels in each bay. The floor is of reinforced concrete with one and one-half inch topping of green colored concrete. Metal doors have been provided for the motor room, one of which is 14 ft by 16 ft. A steel panel wall is used to enclose the mill side of the motor room.

The electrical equipment in the motor room is cooled by circulated air under a slight pressure and the air is filtered by electrical precipitation type air filters. Operations to date seem to indicate that this equipment will be satisfactory from a cleanliness point of view, Figure 6.

On May 13, 1955 ground-breaking exercises were held.

Once construction was actually under way it became

Figure 3 — New mill is under construction in lower right foreground.

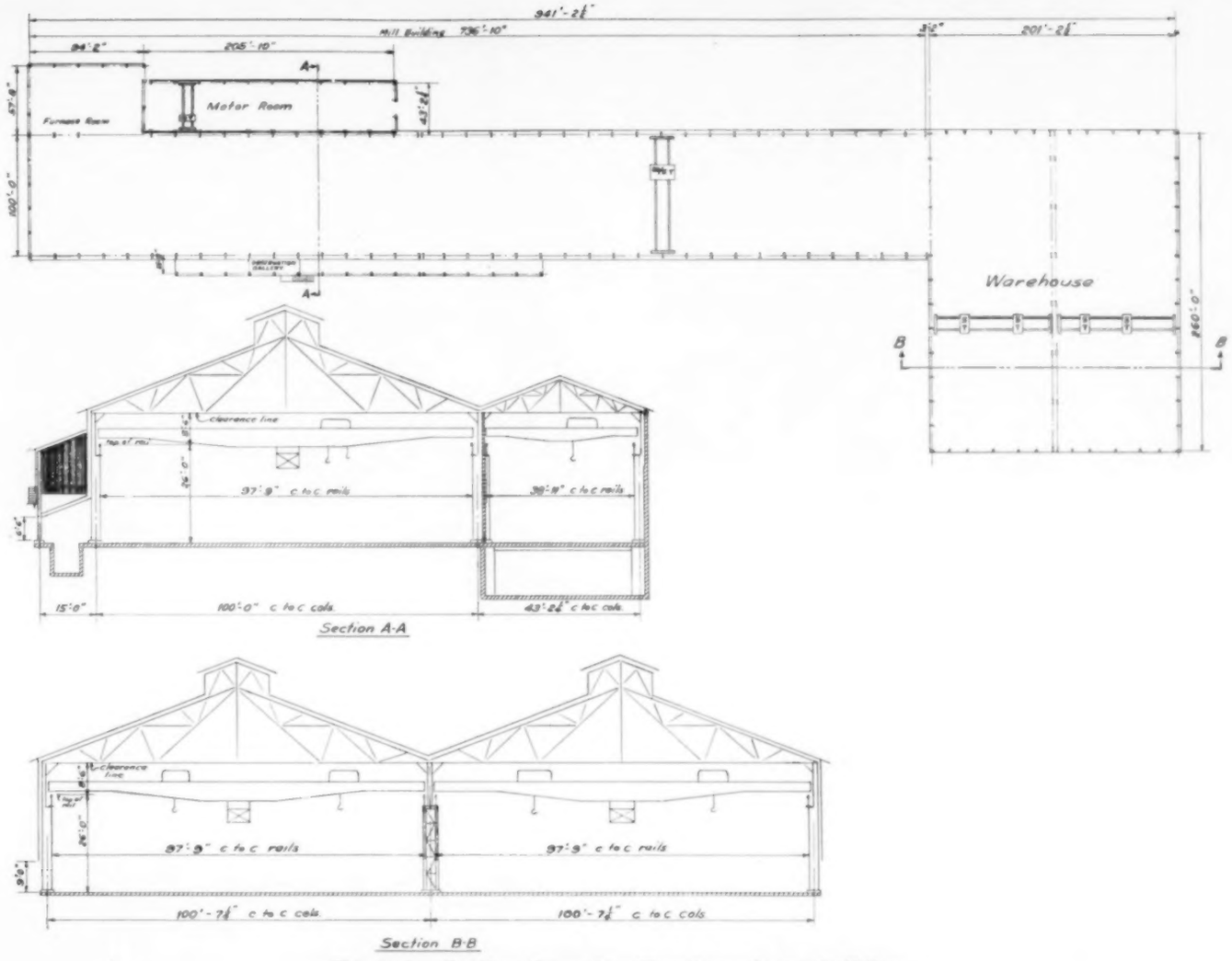


Figure 4 — Section through mill and warehouse building.

apparent that a good job of planning, selecting suppliers and erectors had been done, as progress was rapid. There were no delays of any consequence due to bad planning or incompetent personnel. As the scheduled completion date approached it became apparent that there would be a delay due to failure of the mill supplier to fulfill his early promises on delivery of the mill machinery. The construction superintendent fortunately was able to rearrange his working forces so as to hold the direct extra cost to a minimum. This delay, however has been extremely costly in that it has thrown a monkey-wrench into the planned financing of the mill and has caused serious delays in the time schedule of getting the mill into production.

On November 13, 1956, dedication exercises were held and the first merchant bar rolled. Eighteen months from breaking ground until the first finished product was on the way to one of our customers is not a record, but we at Atlantic Steel felt we had done an efficient job of getting an investment of $9,000,000 into production.

ELECTRICAL EQUIPMENT

Modern steel rolling mills depend to a large extent on the design of the electrical drives and the electrical control systems. A combination rod and bar mill, such as this one, calls for a wide range of speed control. High speed for small sections, low speed for large sections. Motors driving the stands of this mill were selected with a speed range of three to one, with the exception of the six-stand rod finishing drive, which has a range of two to one.

Basically this mill uses standard rolling mill motors of normal design with magnetic amplifier rotating speed regulators.

The mill consists of seven roughing stands, six inter-

Figure 5 — Open type monitor runs full length of building.

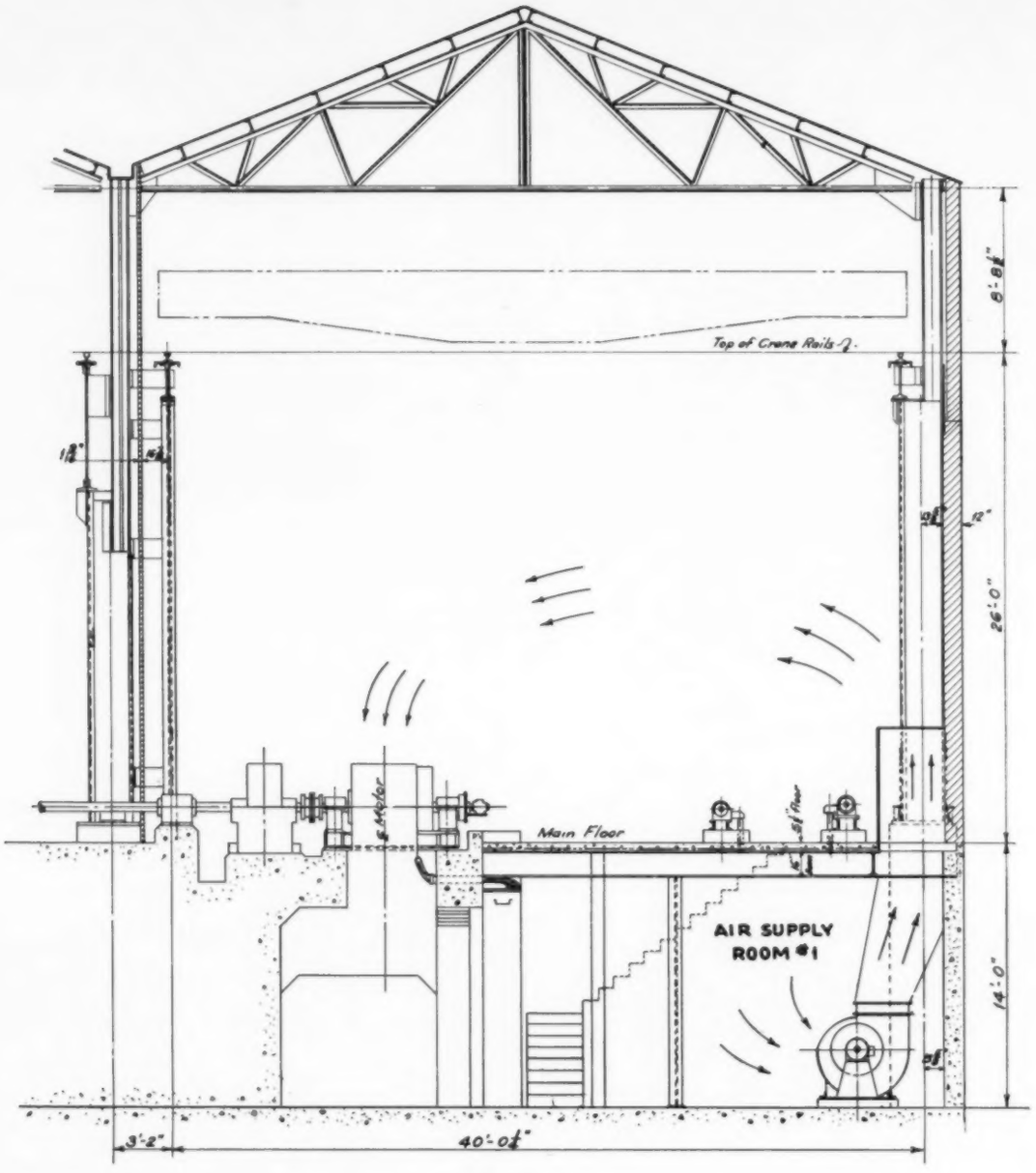


Figure 6 — Section through motor room shows air circulation.

mediate stands, eight finishing stands, one vertical edger stand and provision for adding three more edger stands. Table I gives the horsepower, speed of the drive motors, stands driven, and the power supply.

TABLE I
Main Drives

Drive	Stand	Hp	Speed range, rpm	Power supply
A	1-2	500	350/1040	
B	3	400	400/1200	
C	E-1 (Future)	200	300/1200	
D	4	400	400/1200	1500 kw
E	5	400	400/1200	700 v
F	E-2 (Future)	150	250/1000	
G	6	400	400/1200	
H	7	400	400/1200	
J	8	500	350/1040	
K	E-3 (Future)	150	250/1000	
L	9	500	350/1040	
M	10	600	350/ 980	3500 kw
N	11	600	350/ 980	700 v
P	E-4	150	250/1000	
Q	12-13	800	250/ 750	
R	14-15	800	250/ 750	
S	16-21	2000	500/ 990	

Direct current at 700 volts for driving the mill motors is furnished by two pumpless type ignitron rectifier units, capacity 1500 kw and 3500 kw. Motors driving the roughing mill are connected to a bus that receives its power from the 1500-kw rectifier. The intermediate and finishing mills are connected to a bus receiving power from the 3500-kw rectifier. Equipment is provided for connecting the buses together, if desired, when all motors are operating at the same voltage level.

The twc rectifiers are capable of operating over a voltage range of 350 to 700 volts direct current. This is obtained by using a combination of phase control and regulating transformer taps changed under load, with load ratio control.

The main motor room is 205 ft long, 40 ft wide, and 26 ft to top of crane rail. Ten of the main drive motors are located in the motor room, along with the rectifiers, 480 volt a-c and 250-volt d-c substations, 440-volt control panels auxiliary and exciter motor-generator sets, adjustable frequency control panel, and the master control panel. These are located on the main floor.

The rectifier transformers, and 480-volt a-c transformers are located outdoors and are connected by bus duct to their associated equipment in the motor room. See Figure 8.

The main motor room basement contains main and auxiliary control panels, motor operated rheostats, air filters, and ventilating fans, Figure 9.

The main drive motors in the motor room are equipped with non-recirculating down draft ventilating fans. By means of these fans, air is taken from the motor room floor area through the motors and discharged into the basement plenum chambers. Other fans discharge the air from the plenum chambers to the outside of the motor room.

Air is taken from the motor room, via tunnels, to ventilate the main drive motors located in the mill area and certain auxiliary motors requiring ventilation. These motors in the mill area have enclosures arranged to take air from beneath the base and to discharge it through louvered openings into the mill area.

With the mill proper, there are some 40-odd 230-volt, d-c constant potential mill type 600 series motors. These motors range in size from 7½ to 75 hp.

These constant potential motors receive power from a 500-kw, 250-volt, d-c sealed tube mercury arc rectifier. This rectifier is a complete metal enclosed unit substation with transformer and drawout d-c switchgear section close coupled to the rectifier. This equipment is also close coupled to the switchgear section of the 480-volt, a-c substation.

A 100-kw, 475-volt, d-c, motor-generator set provides power for the auxiliary drives of the pouring and laying reels. The generator of this motor generator set is provided with rotating controlled voltage regulator.

The rotary drum-type shear at the cooling bed is driven by a 75-hp, adjustable voltage d-c mill type motor. This shear is capable of cutting cooling bed products (1.6 sq in. of cross section) at finishing speeds up to 2000 fpm. This shear operates on a start-stop cycle for every cut. It was necessary to furnish the 75-kw, 250-volt generator with special characteristics to provide for rapid acceleration and momentary peak overloads.

The runout table rolls to the cooling bed are individually driven by 123 one-horsepower, 220-volt, a-c motors. A 300-kva adjustable frequency motor-generator set varies the speed of the table motors over a range of 15 to 60 cycles. This adjustable frequency motor generator set is driven by a 300-hp 700-volt, d-c motor connected to the d-c bus furnishing power to the finishing stand motor.

The table motors are operated at 220 volts, instead of 440 volts, in order to use individual plug type connectors with protective fuses mounted in the plugs. This plug connector makes it convenient to disconnect or remove a table motor in case of trouble.

The power distribution system is simply this: the power is brought in at high primary voltage and transformed down to utilization voltages and delivered by short secondary feeders to points of use. The a-c power is supplied at 19,800 volts directly to the main drive rectifier regulating transformers, control transformer, and 480-volt transformer. The two outdoor circuit breakers are rated at 34.5-kv, 1,000,000-kva interrupting capacity, Figure 10.

Figure 7 — Motor drives were selected to give a speed range of three to one except for the six-stand rod finishing drive which has a ratio of two to one.

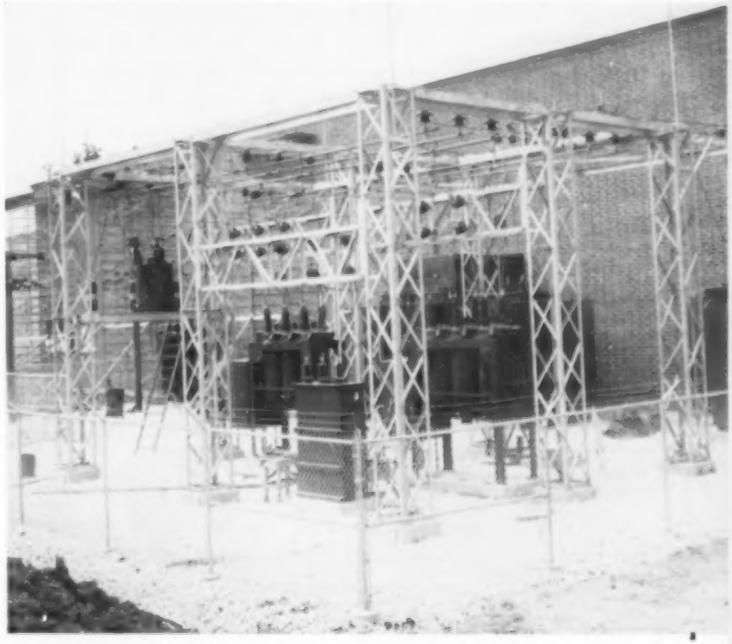


Figure 8 — Rectifier transformers and 480-volt transformers are located outdoors.

Figure 9 — Main motor room basement has main and auxiliary control panels, motor operated rheostats, air filters and ventilating fans.

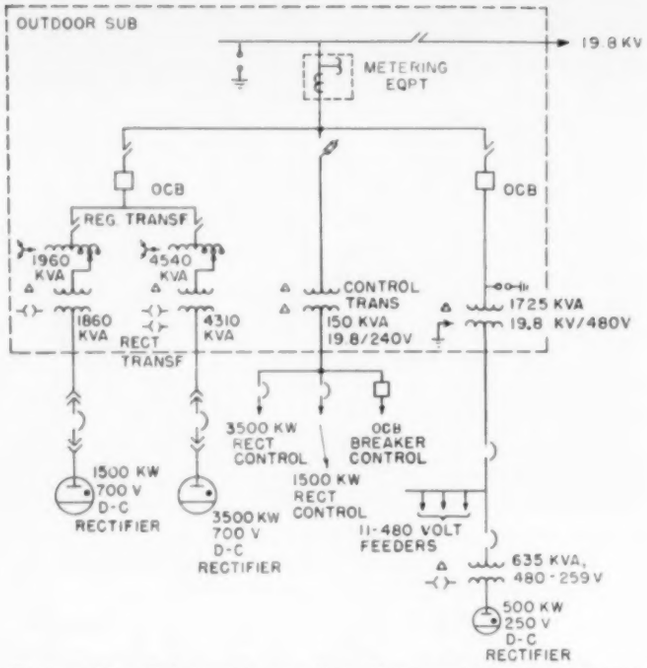


Figure 10 — Schematic one line diagram shows merchant bar and rod mill power system.

UTILITIES

Georgia Power Co. furnishes electric power for all operations at Atlantic Steel Co. We do not generate any a-c power, although we do have a stand-by engine generator set that is rated 300-kw at 250 volts, d-c. This engine generator set is for emergency production of a small amount of d-c power for overhead cranes in case of a power outage by the Georgia Power Co. Electric power service continuity by the Georgia Power Co. at present is very good.

Electric power is distributed to mills, warehouses, and offices by two overhead lines, which are of a triangle spaced wood pole pin type.

The rolling mill under discussion has a connected load of 8375 kva. This load is made up of 6500 kva to main drive rectifiers, 150 kva of control power, and 1725 kva of auxiliary power at 480 volts.

The reheating furnace, 90 tons per hour capacity, uses natural gas for fuel. At the present time a stand-by fuel is not available. Natural gas is purchased from Atlanta Gas Light Co. We have in the plant an underground pipe line distributing this natural gas to points of usage. There is one central metering station, supplied by Atlanta Gas Light Co.

We have a two-stage rotary air compressor with a capacity of 750 cfm at 100 to 120 psi, to furnish compressed air for this mill. This air compressor is located in the mill building, just outside the motor room. In case of failure of this compressor, there is a tie-in with the plant compressed air distribution system. This plant system has a capacity of 3700 cfm at 90 psi.

Atlanta city water is used for cooling the rectifiers, air compressor, heat exchangers, and emergency cooling of the reheating furnace.

A separate recirculating water system was designed and installed for furnishing cooling water for the mill rolls, bearings, and reheating furnace of this mill. This water system has a capacity of 7500 gpm at 40 to 45-psi pressure. This system includes the following:

1. Mill scale settling basin, 20 ft wide by 60 ft long by 23 ft-6 in. deep.
2. Hot water sump, 20 ft wide by 60 ft long by 20 ft deep.
3. Three vertical turbine pumps, each 2500-gpm at 65-ft head.

Figure 11 — Bar mill water recirculating system uses 5000 gpm and has provisions for 7000 gpm in the future.

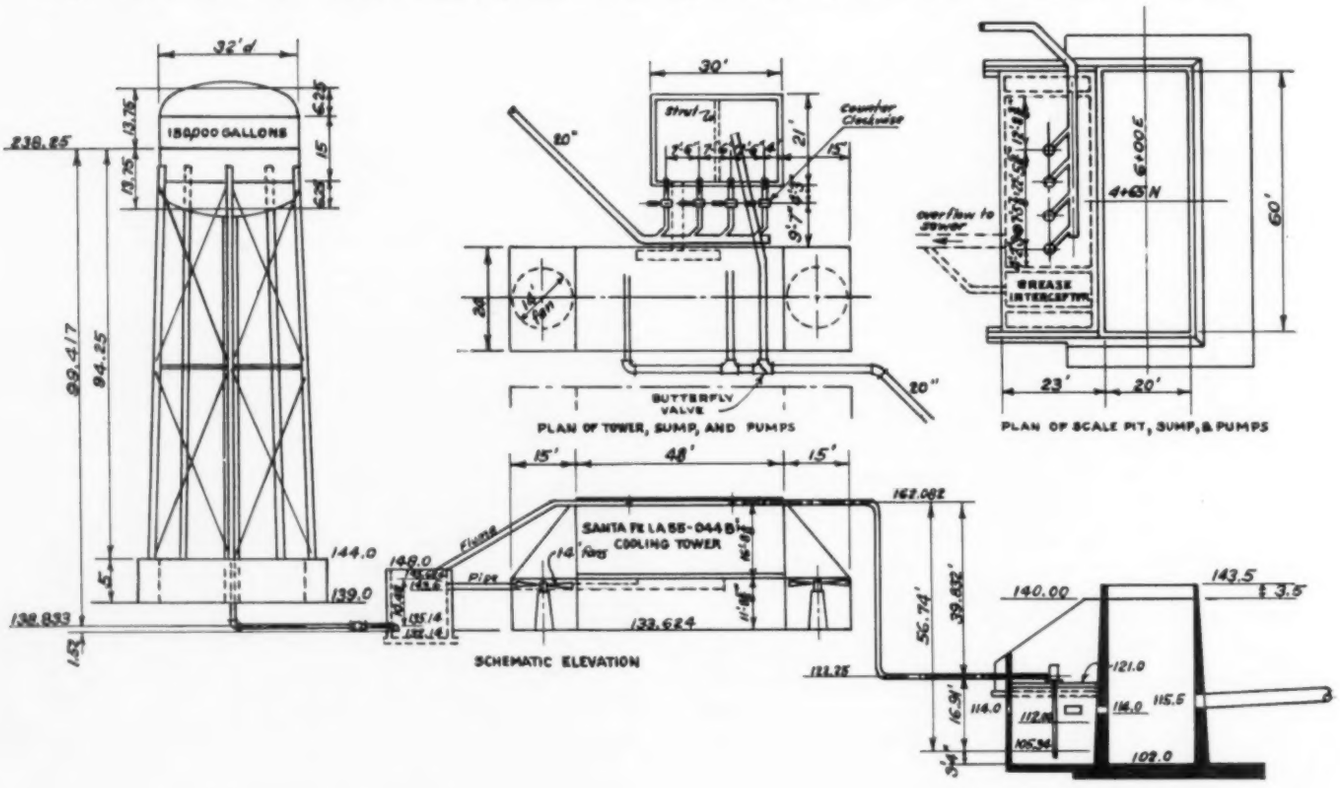


Figure 12 — A drag flight conveyor will be added at a later date for continuously moving scale.

4. One forced draft cooling tower, capacity 7000 gpm.
5. Cold water sump, 21 ft wide by 30 ft long by 16 ft deep.
6. Three horizontal centrifugal pumps, each 2500 gpm at 116-ft head.
7. One storage tank, 150,000-gal capacity, 100 ft above ground level.

During normal operations the scale settling basin and hot water sump carry about eleven feet of water. Based on the theoretical demands of 4200 gpm for mill rolls, and bearings, there is about 20-min retention time for scale to settle to the bottom of this scale pit.

Mill scale is removed from the scale pit with a crawler-type crane and bucket, at regular intervals, depending on tonnage produced by the mill. Scale removal is scheduled during down time of the mill.

Provisions have been made for adding a drag flight type conveyor for continuously removing scale from the scale pit at a later date. See Figures 11 and 12.

To date this mill has created a maximum 30-min demand of 5040 kw. The auxiliaries accounting for a good 20 per cent of the demand. Actual kwhr of energy consumed during the period April 29 to June 24 was 1,228,780 kwhr. Sixty-two and one half per cent of this went to the main drives, 37½ per cent to the auxiliaries. Tonnage produced during this period was 14,329. Based on these figures, the average power requirements are about 86 kwhr per ton produced.

Georgia Power Co. meters on the overhead line serving this mill indicate an average calculated power factor of 81 per cent during July and August, 1957.

ROD AND MERCHANT MILL

The mill consists of 21 stands, 15 of which are used for rolling merchant products, and all 21 for rolling small rods in coils. It is served by a double-fired continuous furnace for heating billets and has a 270-ft long cooling bed for the finished merchant products. Rods are coiled by six laying reels when rolled three-strand, and by two pouring reels when rolled single strand. The pouring reels will also coil nut stock, squares and small flats, Figure 13.

The products which are expected to be rolled are:

Rounds—⅜ to 2 in.
Squares—½ to 1¼ in.
Plates or flats—1 x ¼ in. to 6 x 1¼ in.
Angles—1½ x 1½ in. to 4 x 4 in.
Channels—3 and 4 in.
Beams—3 and 4 in.
Reinforcing bar—No. 3 to No. 11 inclusive.
Rods in coils—No. 5—0.218 to ½-in. diam.

Figure 13 — Arrangement of merchant bar and rod mill and motor room.

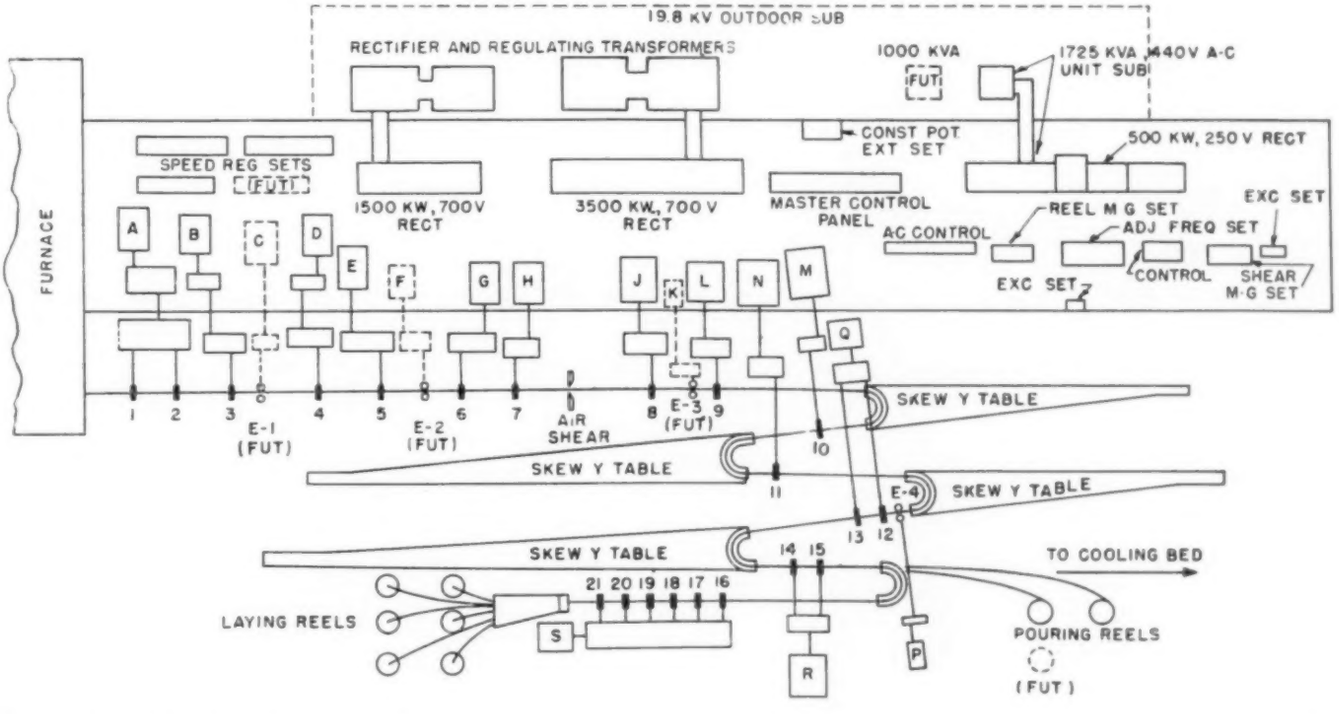


Figure 14 — Billet skids and unscrambler are operated from a control desk by one person.

Figure 15 — Fully mechanized Y-tables and repeaters are used.

These products cover a wide range found necessary for our Southern trade, both in merchant products and wire sizes.

Management's decision to build a combination mill, rather than a mill only for merchant products or only for rolling rods, was guided by trade demand as well as economics. In designing such a mill, ingenuity was used to get certain novel features which we think make the mill one of the best ever built.

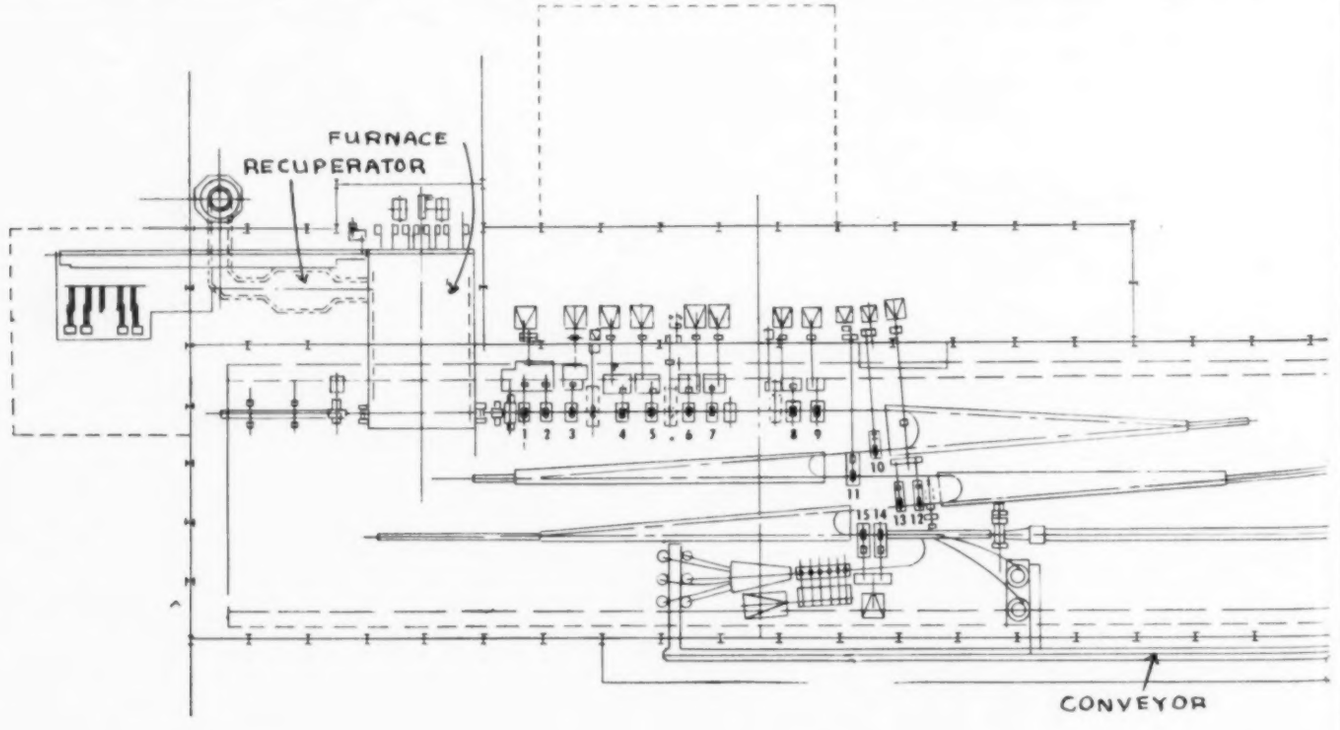
The mill was built to roll more tons per hour of the products mentioned, and with less labor, than other mills for the same purpose.

The builders commenced this economy with what is ordinarily called the billet skids. A machine called the billet unscrambler takes billets from a lift truck in bundles of eight tons and straightens then out and deposits them one at a time onto the charging rolls. All this equipment is operated from a control desk by one person, where on our old mill it takes three people, Figure 14.

The pushout is similar to older types, but improved with hydraulic shifters to position the machine. On the delivery end of the furnace the mechanism has been greatly improved. The pullout rolls can be positioned to each of three passes when rolling rods, or any position which may be needed for rolling merchant products.

We will skip the continuous roughing train for a moment, to the skew tables and repeaters. A mill built to roll only small merchant product sizes and rods would need only repeaters. However, since the range of sizes to be covered could not all be repeated, it was decided to install Y-tables fully mechanized, so that no person with tongs would be needed to work the required passes to make any product rolled, Figure 15.

The mill has both bar and rod, and strip repeaters, which are necessary to handle the full range of sizes.



The rod and bar repeaters are three-strand for rods and deep enough to handle bar sizes. We also repeat ovals, diamonds, and square bars, and it is necessary to have special equipment for this purpose.

At No. 12 stand the mill is equipped with both 11 and 13-in. stands for rolling small and large sizes. These stands, when used on merchant products, are used singly, but on rods they are used as a duo on tandem sets. This feature, in addition to allowing the use of small and large rolls for such products, has one large motor to drive the two stands, which when used singly, gives 800 hp for the one stand. This has proved very helpful in making large angles and flats where the load is heavy, Figure 16.

The drum, or parting, shear is located some 50 ft from the finishing stand toward the cooling bed. It is a rotary shear used to cut a long bar into cooling bed lengths. It has capacity to shear up to 1.6 sq in. and is used on flats, rounds, squares, re-bars, and with special blades, angles. It is a most useful piece of equipment when a single-sided cooling bed is used. See Figure 17.

The cooling bed is 270 ft long, with 17 machined notches to carry over any size product we wish to roll. It is fully mechanized and operated by push-button control from the mill end, giving the operator visibility to both the furnace and the shears. This we think is the best cooling bed which has been built for these products. The men needed to operate the cooling bed—six in all—are the least number used on any bed for this purpose. The product shears and back shear table are fully automatic, Figure 18. We designed and built a set of mechanized cowhorn bins to put more bars in when shearing a number of different lengths simultaneously, Figure 19.

In the rolling of coiled rods, a very fine rugged slat conveyor carries coils from the laying or pouring reels a distance of 230 ft. They are then automatically lifted off by a hook conveyor which travels some 700 ft to the wire department, where they are removed with air-operated hooks. A lift truck with ram completes the operation, Figure 20.

The mill itself consists of four stands of 16 x 38 roughing, three stands of 14 x 34, two roughing stands 12 x 28. Then in the cross-country, we have four stands 12 x 28 and two 11-in. stands. The six-stand rod train is 10 x 24 in.

The bearings for this entire merchant mill are totally enclosed with synthetic liners. The thrust units on the mill, with the exception of stands 16 through 21, are special mounted, double-race ball bearings. These are attached to the outside ends of the rolls with allen-head set screws. The bearings, for both load and thrust, are assembled to the rolls on the bench before being put in the mill. The housings are all closed type with exceptionally wide windows to allow large collared rolls for beams and shapes. The bearings for the rod train, 16 through 21, have a synthetic thrust collar built into the totally enclosed load bearings. These are the same as on merchant mill, except for the thrust collars.

The mill load bearings are supplied with clean water from a circulating system, and have proven very satisfactory as well as economical to operate. The thrust bearings are on the grease system. The mill couplings, gear type with splined spindles and gear teeth, were built to allow angularity of the amounts to roll the widest section called for. These couplings are rattleproof and almost indestructible.

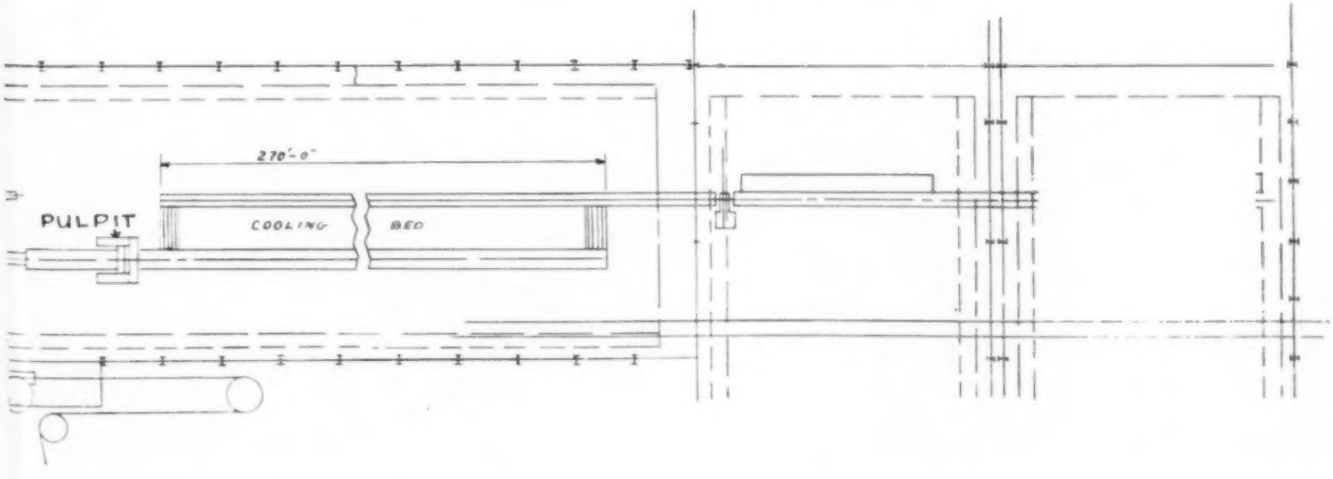
The use of hydraulic fluid to hold up the top roll of all housings, as well as for sliding the housings on the bedplates to get passes alined, is a great help to operators. The repeaters are fixed in one position, and when moving from pass to pass on the rolls, the housing is moved by hydraulic cylinders. There are a number of other uses of hydraulic pressue such as the billet unscrambler, the pushout and the billet selector. In all cases it has proved very dependable.

The mill is provided with nine stands of continuous roughing because of rolling rods. Four cross-country stands with both repeaters and skew tables are for rolling merchant products. It was thought necessary to have four open passes for possible future shapes to be rolled. The mill was laid out to have three vertical sets in the roughing train to edge flats and angles. The foundations are in place for their future installation. When edging is necessary in the roughing train it is now done in the horizontal stands. The cross-country stands numbers 10 and 13 are also used as edgers on flats.

REHEATING FURNACE

Before discussing operations, the furnace must have a brief on its type, size and capacity.

Figure 16 — Layout of bar and rod mill.



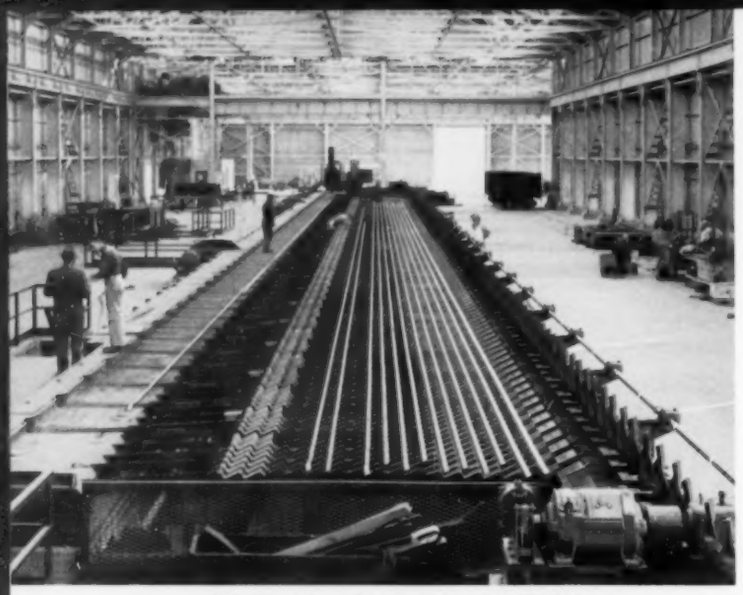


Figure 17 — Cooling bed is 270 ft long.

In almost every mill recently built and installed such as ours, there has been some lack and limitations to the heating furnace.

The furnace (Figure 21) was designed to use billets 2½ x 2½ in. x 25 to 30 ft up to 3½ x 3½ in. x 30 ft. or slab sections 7 x 3 in. or smaller. The tons per hour had been specified as 80. Furnace is double fired, with both sets of burners on top of the billets. The heating zone, which has its burners located about half-way up from the pushout, is fired with much larger burners than the soaking zone. The furnace is 55 ft long from pushin to pushout, and has water-cooled skids for 12 ft in back to allow additional heating capacity by giving a wrap-around effect to the outgoing flame before it gets to the recuperator. The recuperator is located in the flue between furnace and stack. The stack is an ejector type. The controls for the furnace are hydraulic. As previously stated regarding the mill, no manual labor is required to operate the furnace. It is all push-button controlled from a main panel near the pushout. We do not at present have any stand-by fuel but could convert to oil with simple changes.

Many pages could be written on the special features of this furnace. It is an excellent furnace for our work, and so far has given no trouble. It is large enough, it is economical, it is easy and simple to operate. It is a rolling mill man's dream furnace.

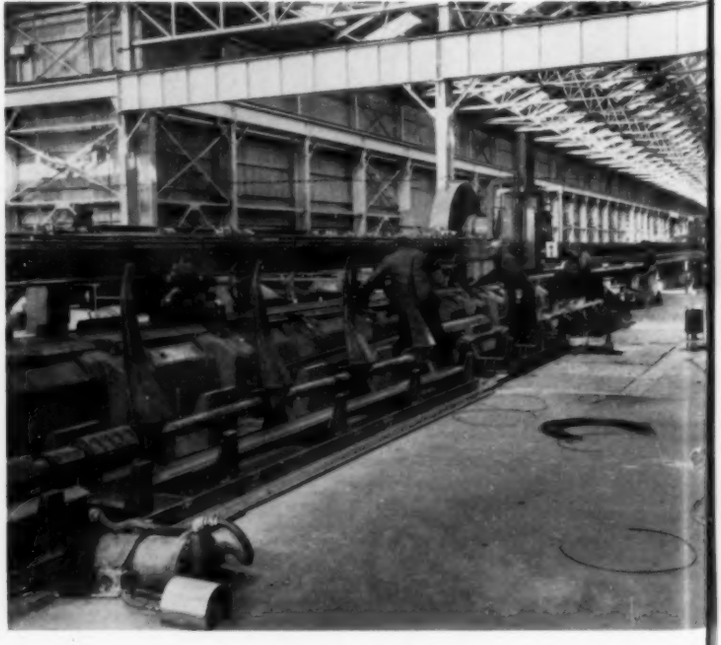
OPERATIONS

Billets for this mill are made on our 25-in. blooming mill and 14-in. continuous billet mill. The 2½ to 3½-in. square billets were a part of the billet mill passes for rolling other sizes. However, the 7 x 3-in. and other slab sizes were all new and were figured out to use a rectangular shape bloom from the bloomer and just draft it lightly in the 14-in. billet mill. Shearing these large slabs has presented a problem. The billet flying shears will cut only 16 sq in., and as 7 x 3 in. was more than that, it was decided to shear these at the up-and-down crop shear entering the 14-in. billet mill. To shear to length on this plan is rather difficult. If trying to get near 30 ft long, and a billet 31 ft is made, it will be too long to go in the 13-in. mill furnace. At the 13-in. mill furnace we can use 25- to 30-ft lengths and thought it an excellent idea to do so; however, the method of pushoff at the cooling bed makes a uniform length billet very desirable. The random length is still in use for rods where the weight of coils can vary.

The billets are made at the billet mill, which is some 700 ft from the 13-in mill, and are loaded onto bolsters and hauled with a straddle truck. At the 13-in. mill we have a large area paved with slag where the billets and bolsters are stored for later use. Near the unscrambler skids an area of 20,000 ft square is paved with concrete. Here a 15-ton lift truck takes billets off the bolsters and places them on the unscrambler. This plan was, for us, better than hauling billets on a railroad car, unloading them for storage with a locomotive crane, and then using an overhead craneway and crane to place them

Figure 18 — Product shears and back shear table are fully automatic.

Figure 19 — Mechanized cowhorn bins are used on shear table.



on the skids or unscrambler. We believe that we have the best system for us.

The first operating crew was brought down from the old rod mill and rolling was commenced on October 1, 1956. It was after many meetings among our industrial engineering department and management that a rate for each of the jobs on the new mill was set up. It was also after several meetings with our local union committees that this first crew was selected. The crew was selected by accepting the man in the old mill with the most seniority on the job nearest to the job he desired.

The first size attempted was No. 6 reinforcing bar, using a 3½ x 3½-in. x 30-ft billet. This was an original layout furnished by the mill builder using the passes, guides and troughs sent by them for this size. The billet length required parting for cooling bed length, so the drum shear was used. The bar was made using seven passes in the roughing mill and four cross-country passes and also using the three-strand rod and bar repeaters.

The next rolled was No. 7 reinforcing bar and then No. 8, all rolled with the equipment for 3½ x 3½-in. billets. We did well on these sizes and were rather proud.

Next size attempted was No. 11 bar and, according to the mill builder, we were supposed to use the skew tables. This was when we found that skewed rolls would turn a small or narrow bar over and over as it approached to enter the next pass, and it would not enter. We decided to skip most of that size, as well as No. 10 and No. 9 bars, until a better way could be devised.

Our roll designer later laid out a way to roll these sizes by using the strip repeaters and we now have no trouble with them.

The next size attempted was No. 5 bar and the rod and bar repeaters. It rolled fairly well, though it was the first size which had to be cut more than once on the drum shear. The No. 4 bar using a 2½ x 2½-in. billet completed the rolling of the first group of sizes. We tried to roll it at 2000 fpm but could not keep it on the cooling bed. The insulated rollers, the electric eyes, and sometimes the operator, caused trouble by doing the wrong thing. We dropped back to 1600 fpm and did better.

Following reinforcing bar we changed the mill to flats. The small sizes, 2 to 3¼ in. wide, formerly were rolled on the old rod mill and the larger sizes, 3½ to 6 in. wide, had been rolled on our 14-in. billet mill. This was the first time that we had used the roughing mill for horizontal edging. Also we used two cross-country stands, numbers 10 and 13, for horizontal edging, giving three edging passes on all flats. This made excellent corners and a nice looking, well rolled bar.

At this stage of rolling on our new mill, we had not commenced using the strip repeaters, so all flats rolled were worked with the skew tables. We really had a problem getting homemade bar turners to work on turning up a wide flat off the skew table to enter the cross-country edging passes. It has been said that necessity is the mother of invention. We were in serious trouble. So one of our roll engineers designed a simple square box about 8 in. with a square bar ¾ in. by the length of the box, approximately 2½ ft welded diagonal inside, which did the trick. It was so simple and worked so well that we quickly tagged it Harmon's rabbit box, because it looked like a rabbit trap.

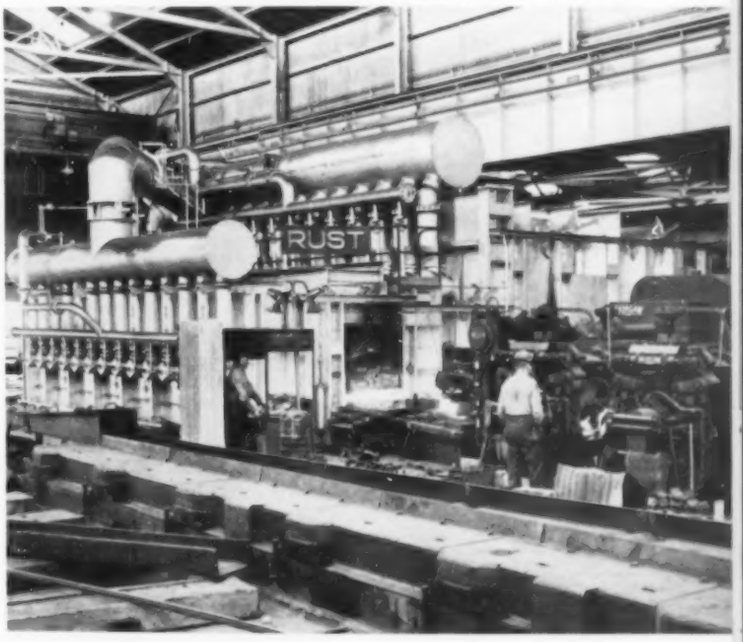
Figure 20 — A hook conveyor takes rod some 700 ft to wire department.

When we reached the 6 x ⅝-in. flat, we put on one strip repeater, on numbers 13 to 15 stand. This proved much better than the skew-Y tables on long bars. So we now repeat most of the range of flats rolled, and we now roll down to 1½ in. wide. We have had trouble with sizes like 1½ x 1 in. as they neither want to repeat nor work on skew tables.

Our next product was large angles. We started to roll 4 x 4 x ½ in. using flat and edging method. Other mills use this method, but some still stick to tongue and groove method. We had trouble with the back of the angle due to not being able to set up close enough, also due to pull in the roughing stands. We gave it up and went to 4 x 4 x ¼ in. which we made very easily. Later, we went back and rolled the ½ in. thickness after learning some tricks.

Next size was 3½ x 3½-in. angles, and then 3 x 3 in.; finally 2½ x 2½ in., which completed the scheduled range on this mill. The flat and edge method is an easy way to make several thicknesses of angles without having trouble with length of legs. In taking a slab billet

Figure 21 — Reheating furnace is rated at 80 tons per hr.



and flattening through a continuous roughing train, and then bending it to make an angle, requires close adjusting on the part of the rolling crew, as well as extreme care to get speeds of various motors adjusted. We like the flat and edge method for rolling angles, and we use it in our 10-in. mill on smaller sizes. We will soon roll unequal leg angles using this same method.

Soon after we had rolled these three products—reinforcing bars, flat bars and angles—it was decided to put on another crew. This brought more headaches because the changes from size to size as well as inexperienced people did not do so well. Inexperienced chargers commenced to tear up the furnace charging machinery. Billets scraped the walls of the furnace, water got off some roll passes, grease did not get to ball thrust units and burned them up. We probably should expect these things, but we did not.

Then, as if we were not having enough trouble, it was decided to put on three crews in the 13-in. mill and two crews in the old mill. Everyone had rights in both mills and they ran back and forth and doubled over, they got tired, and laid off from work.

So we decided to start rolling rods on the 13-in. mill three shifts in March, 1957. The crews we had had rolled rods on the old mill, where they were not too good. After being split five ways—that, is, three crews on the 13-in. mill and two on the old mill—they were spread too thin.

To jump from a 14-stand mill using 1½-in. billets to a 21-stand mill using 2½ x 2½-in. billets, fully mechanized, was more than they could do. The speed was a little different in that the old mill finished at 2000 fpm and the new one at 5000 fpm. We tried to start it off slow, but when you slow down the finishing to 4000 fpm, the steel passing through the first five stands is too cold to make it through the finishing train. So we went back up on the speed. Inexperience commenced to show up. Some thrust bearings got in wrong on No. 21 stand and wore out and stalled the rolls, breaking two expensive spindles. There was another case in which a reel operator tried to dump before time, or out of time, and wrecked a gear reduction set. Mill scrap from the repeaters got so far ahead of the winder that we had to drag scrap to the outside yard to keep going.

At this writing we have had four short rollings on rods, about 1½ weeks each, sandwiched in between merchant products. None of the rollings has been satisfactory so far as production is concerned. However, the rods we rolled—approximately 7000 tons to date—have been extremely close to gage and a very excellent coil.

We are not discouraged, although not at all satisfied, and think more experienced people will learn to roll rods on this mill just like any other new mill.

The layout, buildings, motors, equipment and warehouses are ideal for the rolling of these products. Surely our company has provided the necessary mill to compete with our neighbors and supply our trade. It is one of the finest layouts of a combination rod and merchant mill that can be designed and built.

We needed such a layout, we have it and are going to run it for a long time.

Revised and rearranged collection of articles which appeared in the Iron and Steel Engineer between 1943 and 1950 . . . a book for rolling mill men and for anyone interested in rolling mills and roll design . . . written from a practical viewpoint by one who has had considerable experience in the art of roll design.

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CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, January 27, 1958—Dinner 6:30 P.M., Meeting 8:00 P.M.

"**Guided Missiles,**" by Gordon Artley, Assistant for Guided Missile Test Facilities, Army Ballistic Missile Agency, Redstone Arsenal, Huntsville, Ala.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, January 14, 1958—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"**Development of Atomic Power and Its Possible Application in the Steel Industry,**" by Howard D. Philips, Engineer in Charge of Instrumentation, Niagara Mohawk Power Corp. and Atomic Power Development Associates, Buffalo, N. Y.

Sheraton Hotel, Buffalo, N. Y.

CHICAGO SECTION

Tuesday, January 7, 1958, Dinner 6:15 P.M., Meeting 7:45 P.M.

"**Chicago District Steel Industry—Past and Future,**" by Hjalmar Johnson, Vice President, Steel Manufacturing, Inland Steel Co., Chicago, Ill.

Phil Smidt's Restaurant, 1205 N. Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, January 21, 1958—Social Hour 6:00 P.M., Dinner 6:30 P.M., Meeting 8:00 P.M.

"**Application of High Speed Computer to Steel Plant Problems,**" by Dr. Melvin J. Greaves, Assistant Chief Engineer of Metal Division, Arthur G. McKee & Co., Cleveland, Ohio

University Club, Cleveland, Ohio

DETROIT SECTION

Tuesday, January 14, 1958—Dinner 6:30 P.M., Meeting 8:00 P.M.

Ford Steel Division Night

"**Practical Applications of Welding,**" by Richard J. Osborn, Superintendent, Maintenance, Rolling Mill, Steel Division, Ford Motor Co., Dearborn, Mich.

"**Information Please,**" Panel on Engineering Maintenance and Operations, and Everyday Steel Mill Problems.

Dinner and Meeting, Central Office Building, Ford Motor Co., Dearborn, Mich.

LOS ANGELES SECTION

Monday, January 13, 1958—6:30 P.M.

"**Blast Furnace Operations with Western Materials,**" by John D. Saussamann, Division Superintendent, Iron and Steel Div., Kaiser Steel Corp., Fontana, Calif.

Michaels Restaurant, 6309 East Washington, Los Angeles, Calif.

PHILADELPHIA SECTION

Saturday, January 4, 1958—Dinner 6:00 P.M., Meeting 7:00 P.M.

Old Timers Night

"**Measuring the Investment Worth of Capital Expenditure Proposals,**" by A. D. Howry, Maintenance Improvement Engineer, Alan Wood Steel Co., Conshohocken, Pa.

"**Structural Steel Handling with Mobile Equipment,**" by P. F. Walker, Mechanical Engineer, Service Division, Bethlehem Steel Company, Bethlehem, Pa.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, January 13, 1958—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"**Automatic Gage Control Through Elimination of Transport Time and Distance,**" by O. E. Orbom, Manager, Electro-Mechanisms Dept., F. J. Schoepf, Field Electronic Engineer, and J. B. Murtland, Jr., Supervisor, Electronics Design Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Wednesday, January 29, 1958—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"**Card Programming Controls for Reversing Mills,**" by E. H. Browning, Manager, Metal Working Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

Tuesday, January 21, 1958—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Columbia-Geneva Steel Division Night

"**Improved Rod and Wire Patenting Facilities at Pittsburg Works,**" by James E. Leaver, Sr., Staff Engineer, Wire Mill, and Glenn R. Decker, Product Metallurgist, Wire and Wire Products, Pittsburg Works, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

Shattuck Hotel, Shattuck and Alston Way, Berkeley, Calif.

UTAH SECTION

Monday, January 13, 1958—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"**Gears in the Steel Industry,**" by J. J. Stolz, Vice President, Engineering, The Tool Steel Gear and Pinion Co., Cincinnati, Ohio

Skyliner Cafe, Provo, Utah

YOUNGSTOWN SECTION

Monday, January 27, 1958—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"**Steel Industry in Europe,**" by R. C. Gintert, General Manager, Warren District, Republic Steel Corp., Warren, Ohio

422 Club, Youngstown Road between Girard and Warren, Ohio

Venezuela Harnesses River to Power New Steel Plant

▲PUERTO ORDAZ, Venezuela, a five-year-old town of 10,000, is the newest in Venezuela and is now devoted single-mindedly to loading iron ore into ocean-going ships. The ore comes from the fabulously endowed Cerro Bolivar, where it is mined from a hilltop and carted in freight cars 75 miles to Puerto Ordaz. These operations, a function of U. S. Steel's Orinoco Mining Co., are the present sole reason-for-being of Puerto Ordaz.

This will change by April of next year when the Venezuelan government expects to open up the first phase of vast industrialization plans for the area, now uninhabited except for Puerto Ordaz itself. At that time a new $36,000,000 dam on the rushing Caroni River, 10 miles south of Puerto Ordaz, will begin to provide power to an equally new steel mill now under construction. The mill, costing ten times as much as the dam, will produce 650,000 metric tons of finished steel in its first-stage production to be completed in 1958. Eventual capacity is 1,200,000 metric tons of finished products. Along with the construction of the mill is the building of a workers' community to house 85,000 persons.

The Caroni dam will eventually produce 300,000 kw of electrical power through six Francis turbines activating six 50,000-kw generators. This capacity will not be reached for several years however; 50,000 kw, in fact, is the estimate for 1958 and 200,000 kw for 1959. The steel mill will consume practically all this power.

The Caroni is one of Venezuela's greatest natural resources, and the 130 miles of it south of the juncture with the Orinoco River has a hydro-electric potential of more than 8,000,000 kw, more than half of which is economically usable.

THE NEW STEEL PLANT

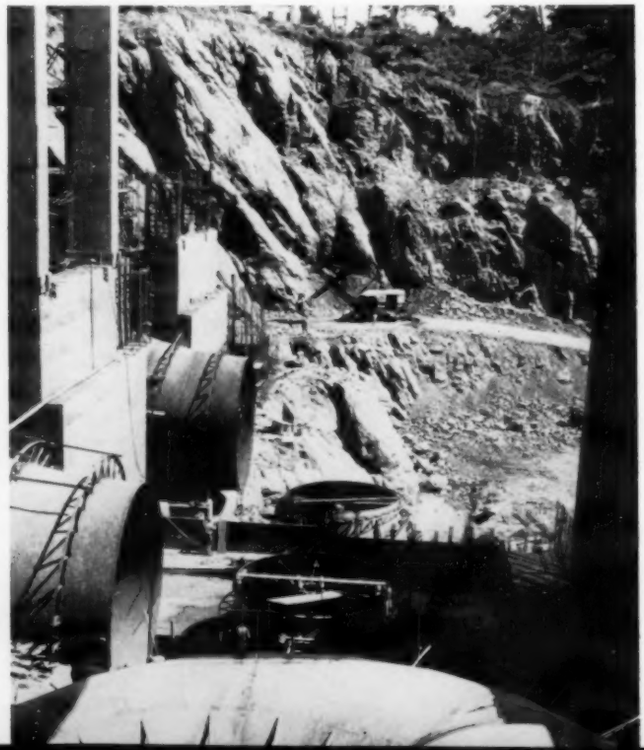
The new steel plant will occupy a tract of 2,700,000 sq meters (667 acres) on the banks of the Orinoco River. Its initial first-stage capacity will be 650,000 tons per year of finished products by 1958. Eventual capacity of 1,200,000 tons per year is not expected to be reached until late 1960 or early 1961. This amount is thought to be sufficient for Venezuela's own needs at that time. At present there are no plans for production for export purposes. Steel products to be manufactured in the first-stage include seamless steel tubing, structural rolled sections, rails, reinforcing rods, steel coils, galvanized wire, barbed wire and nails. Tubing and ingots of cast iron will also be produced.

Seamless steel pipe for the oil industry and some wire are the only products contemplated for the industry's first production in 1958.

Cost of the first-stage facilities will be $360,000,000. By 1959 the second-stage will be under way, costing an additional $60,000,000. Besides an additional 550,000 tons

Figure 1 (left) — Ore train snakes its way down Cerro Bolivar (iron mountain) on 75-mile trip to Puerto Ordaz. From Puerto Ordaz, iron ore is shipped by boat up the Orinoco River to U. S. steel mills.

Figure 2 (right) — Giant penstocks will carry water from the dam to the power station below. Here will be located six Francis turbines activating six 50,000-kw generators.



GRANITE CITY STEEL COMPANY'S basic steel expansion...

another example of Service to the Steel Industry by

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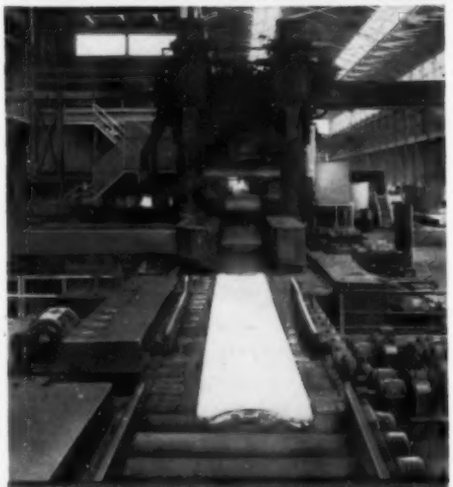
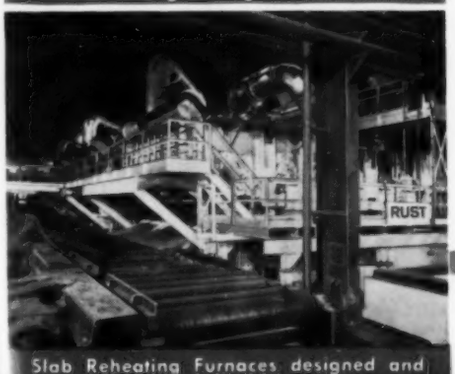
Blooming Mill and Other Plant facilities constructed by The Rust Engineering Co.



Blooming Mill Equipment erected by The Rust Engineering Co.



Slab Reheating Furnaces designed and constructed by Rust Furnace Co.

The construction of the $55,000,000 expansion of Granite City Steel Company's steel making and rolling capacities at Granite City, Illinois, completed 1953, was handled by The Rust Engineering Company and its subsidiary, Rust Furnace Company. The work included blooming mill, hot strip mill, open hearth furnaces and other steel manufacturing facilities. The stacks for the three new open hearth furnaces were built by Rust's chimney division. The continuous reheating furnaces were designed and built by Rust Furnace Company.

To the steel industry, The Rust Engineering Company offers the design and construction of complete facilities and all auxiliaries, including such units as steam generating plants, complete melt shops, turbo-blower facilities, water and waste treatment units and all types of steel mill furnaces. Write for details.

THE RUST ENGINEERING COMPANY

and Subsidiary: **RUST FURNACE COMPANY**

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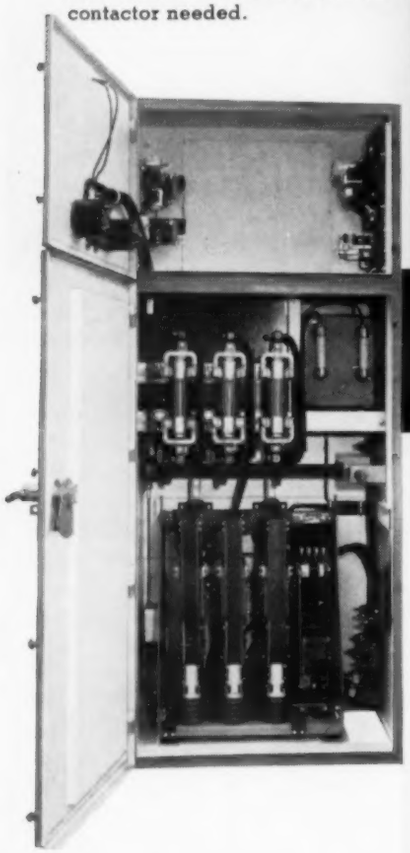
Offices in other principle U.S. and Canadian cities

The most complete synchronous motor protection you can buy

Above and at right • Four EC&M 1000 HP, 2300 Volt Synchronous Starters on air-compressor drives in Chrysler Corporation's new Ohio Stamping Plant at Twinsburg. Purchased and installed by Hatfield Electric Co., Cleveland, Ohio.

Below • Inside view of starter showing compact arrangement of fuses and contactor. The three arc shields slide out for quick access to both front and rear contacts — no draw-out of contactor needed.



EC&M 2200-4800 VOLT STARTERS

• A push of the "start" button gives you complete protection during starting and running—*plus* EC&M *fully automatic synchronization.* Throughout the entire sequence, motor windings are completely protected and synchronization occurs at the most favorable time. Should the motor pull out of step because of voltage dip or overload, the field is automatically removed. Re-synchronization occurs when the motor re-accelerates the load. Short circuit protection is provided by current-limiting power fuses working in conjunction with EC&M's *"certified"* high-interrupting-capacity ZHA air-break contactor.

For complete details...

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THE ELECTRIC CONTROLLER & MFG. CO.

A DIVISION OF THE SQUARE D COMPANY

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of steel per year, the second-stage will manufacture steel plates and sheeting.

Plant will operate the biggest electrical reduction furnaces in the world, comprising nine furnaces, each equipped with 15,600-kvar condenser and 33,000-kva transformers, using, during the first-stage production, 225,000 kw of hydro-electric power of the Caroni plant (twice as much as the city of Caracas consumed during 1956).

Steel will be made in "Siemens Martin" open hearth furnaces.

Construction of the mill will involve equipment from fifteen different U. S. manufacturers.

Housing for workers in the first-stage production will be in the neighborhood of 5000 units for 25,000 inhabitants; second-stage production housing will involve an additional 12,000 units for an estimated 60,000 persons. The new community, with its estimated 85,000 inhabitants, is planned for completion simultaneously with the first and second stages of steel production. This will involve a total outlay of $1,200,000 for housing alone.

Railroad Cars Weighed Without Uncoupling

▲ THE first successful method of weighing railroad freight cars without stopping, switching or uncoupling them was recently demonstrated.

This new system, called railweight, will increase the speed of rail shipments by 7.4 per cent, add the equivalent of 25,000 new railroad cars, detect dangerous loading, and increase the railroads' earnings in excess of a quarter of a billion dollars annually, according to the International Railroads' Weighing Corporation of Indianapolis, Indiana, which developed it with the cooperation of the Monon Railroad in their South Hammond Yard.

Railweight weighs the cars individually while the whole train runs over the scale. The key to the system is a set of specially designed rails at the approach to a standard scale which eliminates the bind between car couplers. Heretofore weighing cars while coupled and in motion has been impossible because of the transfer of weight between cars through the bound couplers which made one car weigh heavy while the other weighed light.

One railweight installation in a classification yard's main incoming or outgoing track can automatically weigh every car passing through it. This does away with the costly and time-consuming process of switching every car which must be weighed to a separate weight track; uncoupling it; weighing it; and returning it to its proper classification track.

Studies have revealed that it costs the railroads an average of at least ten dollars for each of the approximately 22,000,000 weighings they make each year just for the direct costs of switching and weighing. This $220,000,000 cost does not include the cost of track and land, car waiting time, and the damages inherent in the present method. These could double the savings and increase the railroads' present $900,000,000 annual earnings enough to bring their return on their investment in line with that of other businesses.

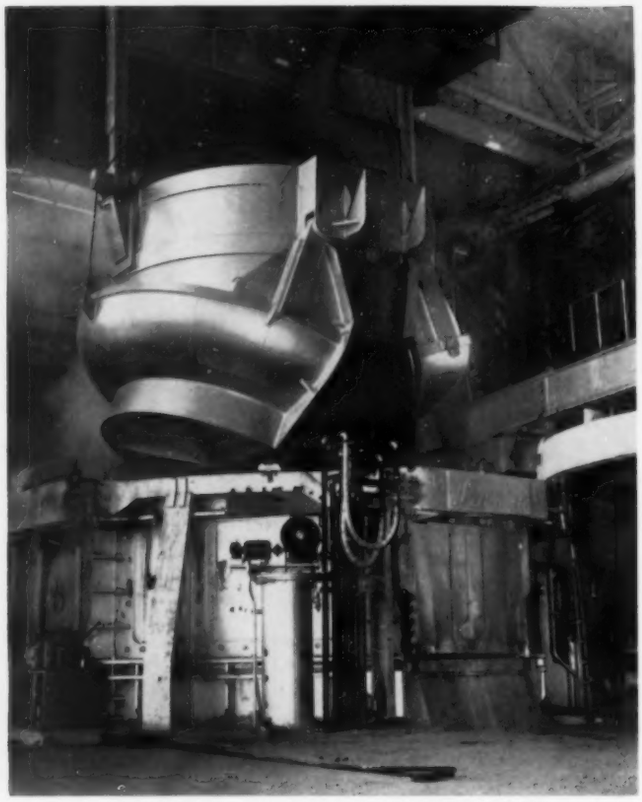
The railweight units will be installed by the Internation Railroads' Weighing Corporation, without capital investment by the railroads. The average cost will be less than 25 per cent of the amount the railroads are now spending on direct weighing costs alone.

The basic problem which has faced those responsible for weighing cars has been the fact that weights of adjoining cars are transferred from one to the other through binding in their couplers. When cars are pulled along tracks, couplers will "jiggle" until one rides high on the other—and the lower one bears all or part of the weight of the adjoining coupler which may run as much as 400 lb and may bear a portion of the weight of the adjoining car as well. Since regulations call for weighing huge freight cars with errors not to exceed 0.2 per cent plus half the resolution of the scale used, the matter of coupler bind on random cars has heretofore absolutely precluded weighing coupled cars in motion. The maximum tolerance of 150 lb in 50,000 meant expensive weighing. Actually, heretofore cars have been weighed in the following manner: As a train approaches a yard, it is switched to a side track. There another switching operation takes place, and those cars which must be weighed are separated from "non-weighers." Weighers are placed on a weigh track awaiting their turns at a scale.

The railweight system introduced in Hammond consists of rails at the approach to the scale, which vary in elevation according to precise specifications, the principles of which were discovered and patented by Edward R. Marden of Aurora, Illinois. Mr. Marden designed a rather abrupt rise in track level. When the rear truck of a car passes over this rise, the bottom guide of the fore coupler forces that coupler up and forces the rear coupler against its top guide and down. A drop, not quite as great as the rise, follows a few feet down the track, and reverse action on the couplers breaks any bind which might have remained after the cars traversed the rise. The cars are then pulled on the balance of the approach track, held level over a scale where the front truck of each car is weighed to strict tolerance, automatically and recorded; then the rear truck, and the two added to give the weight of the car. This "two draft" weighing offers the advantage of determining not only total car weight, but also distribution of load to preclude over-loading one end of the car resulting in possible strain on equipment which might lead to mal-function and accidents.

Any standard scale and recording device can be used.

Savings on direct weighing costs should be approximately $8.00 a car.



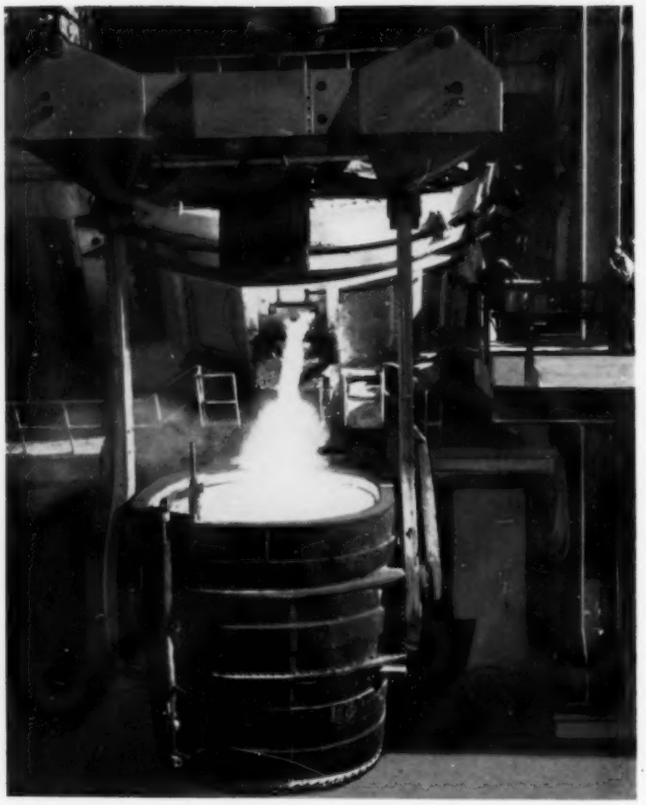


Figure 1 (left)—Charge of steel scrap is dumped from a bucket brought into position by an overhead crane. Roof of furnace is swung aside to right for the charging operation. Figure 2 (right)—The plant's two new electric furnaces, each rated at 175 tons of steel per heat, can produce a total of 408,000 tons annually.

Republic Dedicates New Facilities at Gadsden Plant

Figure 3 (left)—In this new 54-in. hot strip mill, slabs of steel which have been rolled previously to $\frac{5}{8}$ in. are reduced to strip which is then coiled for further processing. Figure 4 (right)—This 54-in. tandem cold reducing mill rolls steel down to 0.015 in.

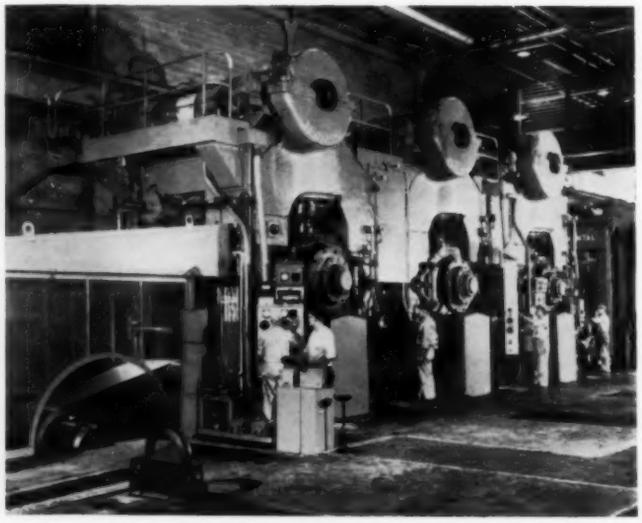


Figure 5 (left)—The 54-in. temper mill gives steel the hardness and toughness specified and leaves the steel with the smooth surface needed for high quality finishing, such as enameling.

Figure 6 (right)—In new galvanizing line, a continuous strip of steel goes through cleaning tanks, then enters a hot zinc bath where it picks up its galvanized coating.

▲ LATE in October Republic Steel Corp. dedicated their new steelmaking facilities at Gadsden, Ala. These new facilities add extensively to Republic's capabilities in this district. The more important units completed in this program include two electric furnaces, each rated at 175 tons per heat, which will have an annual ingot capacity of 408,000 tons. These two units increase Gadsden's steelmaking capacity from the 789,000 tons available from their existing eight open hearth furnaces to a total of 1,197,000 tons, a gain of more than 50 per cent.

New strip mill facilities completed can produce hot-rolled, cold-rolled and galvanized sheet and strip steel. Some 30,000 tons of finished product a month can be produced by the new mill.

The strip mill includes a 54-in., four-stand hot strip mill; a 54-in., three-stand tandem cold mill; a 54-in. temper mill; a continuous pickle line which can handle 20-ton coils; a 48-in. continuous galvanizing line; an annealing department; 48-in. cold cutting and hot cutting lines, and a multiple slitter.

The finishing speed of hot strip mill is 1450 fpm. The new part of the hot strip mill consists of a train of four finishing stands. Initial breakdown is done in an existing plate mill.

This equipment will enable the Gadsden plant to produce hot and cold rolled sheet, and galvanized sheet up to 48-in. wide in coils or cut lengths.

The overwhelming majority of cranes and pulpits being equipped with air conditioning are Lintern equipped.

The reasons for this are contained in new, 20-page Bulletin AC-573 which describes Aire-Rectifiers for each temperature range of cab, also models for pulpits.

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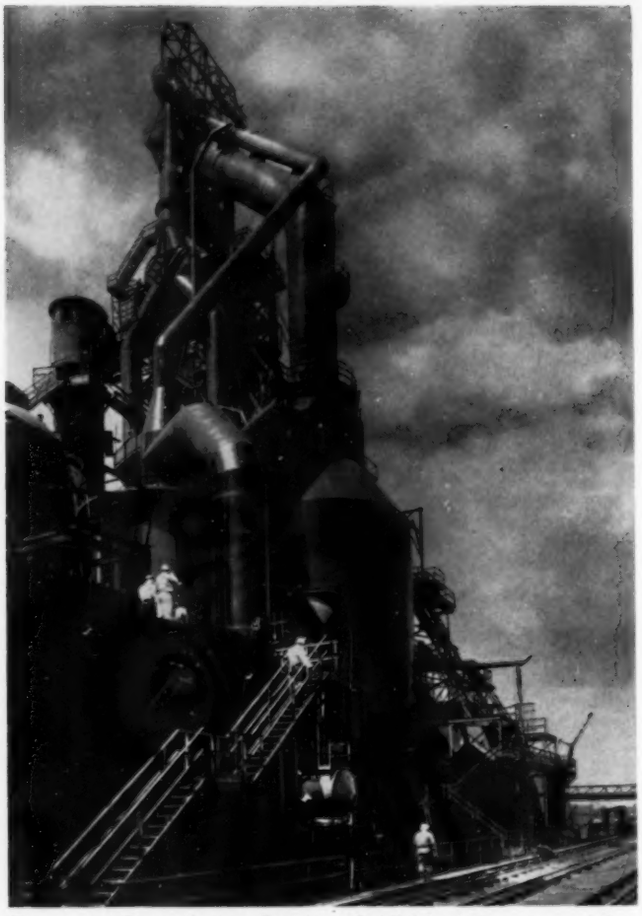


Figure 1—Great Lakes Steel's "A-1" blast furnace, with a hearth diameter of 30 ft-3 in., is one of the largest pig iron producing plants in the world. Its rated production is 50,000 tons of iron per month.

Expansion Program at Great Lakes Steel Corp. Nears Completion

▲EXPANSION and improvements at plants of the Great Lakes Steel Corp. represent an important part of National Steel Corp.'s total capital expenditures of $377,467,675 during the period 1952-56. In addition to this figure, which includes improvements in existing facilities and investments in raw materials companies, it is estimated that $85,000,000 to $90,000,000 more will be spent in 1957, making National Steel's total capital expenditures from 1952 through the end of this year nearly $500,000,000.

The program during the past five years has brought additions to steelmaking capacity and the installation of the most modern facilities of many types throughout the operations of National Steel Corp. The continuation of the program is designed to further increase capacity and help meet the country's rising need for steel.

Expansion of 1,000,000 tons in annual ingot capacity and additions and improvements in finishing operations are included in the program, and by 1958 the ingot capacity of National Steel will have increased from 6,000,000 to over 7,000,000 tons per year.

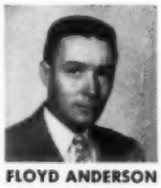
The expansion program at the blast furnace division of Great Lakes Steel Corp. since 1952 has practically doubled the coke and iron production.

A complete new coke and by-product plant was installed, consisting of the No. 3 battery of 70 ovens and the No. 4 battery of 78 ovens, having a capacity to carbonize 3800 tons of coal per day. The addition of 148 ovens makes a total of 394 ovens, with a capacity of 7900 tons of coal per day, producing 5600 tons of furnace coke. The new by-product plant includes an ammonium sulphate plant and a benzol plant.

The program also included the construction of the new "D-4" Blast Furnace, with complete auxiliaries, and the rebuilding of "A-1" Furnace.

The "D-4" Furnace has a hearth diameter of 28 ft 0 in. and is 108 ft 0 in. high. This was a complete new installation and included a new No. 3 Ore Yard, 230 ft 0 in. wide by 1341 ft 6 in. long, having a storage capacity of 900,000 gross tons, with three new 15-ton ore

Here's how your NATIONAL brush man helped one steel mill increase brush life 400%



FLOYD ANDERSON

Six-month brush life was the most this eastern steel mill could coax out of its 1500 kw generator. The result, reports "National" Carbon Brush Man Floyd Anderson, was frequent down time plus some mighty expensive *extras*.

Rapid wear, film stripping, threading and grooving resulted in frequent stoning. Excessive maintenance made the down time problem even more costly.

Floyd analyzed the generator's work load and recommended "National" carbon brushes, grade N-4. Brush wear was reduced immediately. "National" N-4 brushes are averaging two years' service on this generator – a 400% improvement in performance.

Floyd Anderson and his fellow "National" Carbon Brush Men have been solving industrial brush problems for years. Their experience and training – backed by "National" *long term brush development*–make them the logical consultants on any industrial brush application.

Call them today or write National Carbon Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

The terms "National", "N" and Shield Device, and "Union Carbide" are registered trade-marks of Union Carbide Corporation

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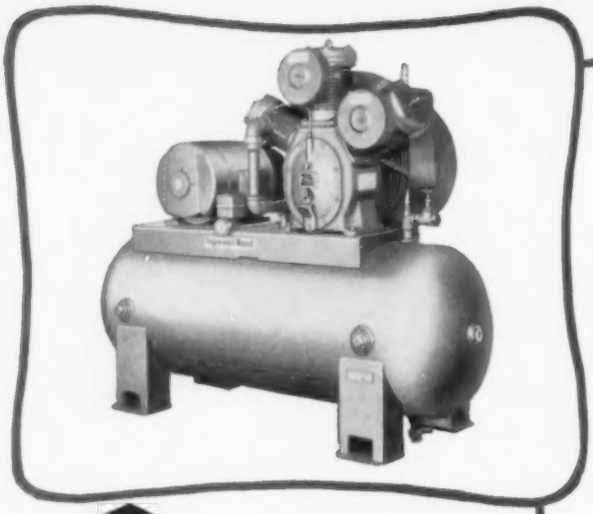

Type 30... A 15 horsepower unit mounted on receiver. Other units, ½ to 20 horsepower.

Type 40... This 125 horsepower Motor-compressor has built-in motor drive. Other sizes from 25 hp.

from ½ to 125 horsepower

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Wherever you need dependable, low-cost air power in the ½ to 125 horsepower range, Ingersoll-Rand air-cooled compressors offer attractive savings. Installation, operating and maintenance costs are low. These units are completely air-cooled—no water piping or jackets to clog, no water to freeze. Multi finned-tube intercoolers with forced-draft cooling keep compression efficiency high. Ask your Ingersoll-Rand representative for full information.

TYPE 30 — ½ to 20 horsepower... These compressors with their outstanding 'Balanced-V Construction' have become first choice among all who look for top operating efficiency combined with low-cost maintenance. Each combination of cylinder sizes is designed to give the most compressed air at the desired pressure; single stage units for 40, 60 or 80 psi; two-stage units for 125, 200 or 250 psi. Type 30 compressors are available as tank mounted, baseplate mounted or bare compressor units. They offer unique money saving features not found in other units.

TYPE 40 — 25 to 125 horsepower... These efficient two-stage, air-cooled units are available with three types of drive; built-in electric motor, flexible-coupled or V-belt. Dual control permits choice of constant speed or automatic start-stop control. Available for discharge pressures ranging from 80 to 200 psi. Channel Valves are efficient, quick-acting and air-cushioned for quiet operation and long service life.

Install Anywhere

- no danger of freezing
- no special foundation
- small floor space

Low-Cost Operation and Upkeep

- no cooling water required
- low maintenance
- regulation to meet requirements

Efficient Compression

- liberal valving
- large capacity intercooling
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Figure 2—The Great Lakes Steel Corporation plant, located in Ecorse, Mich., is convenient to both water and rail transportation. Not shown is the blast furnace division located at Zug island, nearly three miles north of the main plant.

bridges and a fourth one now under construction. Also included was a new Blower House, with two 125,000 cfm turbine-driven blowers, and a new boiler house, with five 100,000-lb per hr boilers burning coke oven and blast furnace gas. A new water intake and pump screening station was installed to serve the new blast furnace and coke plant facilities.

Old "A" blast furnace was torn down and completely rebuilt with new stoves and gas washing and cleaning facilities. New "A-1' Furnace is the largest in the United States, with a hearth diameter of 30 ft 3 in. and 110 ft 0 in. high.

To serve the new furnaces and coke plant, a coal and limestone storage yard was installed having storage capacity for 109,000 tons of coal and 524,000 tons of limestone. Coal and limestone are discharged by self-unloading boats into a receiving hopper, from which coal is handled by conveyor belt and stacker at the rate of 2500 tons per hour and limestone at the rate of 4500 tons per hr.

A new No. 3 gas booster station was installed, with three 45,000-cfm, gas boosters, to deliver surplus blast furnace gas to the new River Rouge Power Station of the Detroit Edison Co. Provision was also made to deliver straight coke oven gas to the steel plant, Ecorse, instead of mixed coke oven and blast furnace gas.

Presently under construction and

(*Please turn to page 186*)

Figure 3—The soaking pit building includes ten blocks of four pits, each pit is 8 ft-6 in. wide by 25 ft long and 12 ft-9 in. deep. The coke oven gas-fired pits have a total capacity of 280,000 tons per month.

Figure 4—Annealing capacity was increased to 170,000 tons per month with the installation of ten additional eight-stack and seven four-stack 60-in. diam coil annealing furnaces and 46 single stack coil annealing furnaces for 72-in. diam by 200-in. high coil stacks.

FOR VOLTAGES UP TO 600...

There's a *Safe and Dependable* BUSS Fuse or FUSETRON Fuse to fit the needs of every user

If you want Plug Fuses . . .

Use BUSS Clear Window Plug Fuses

Their one-piece body and "safety" design guarantees protection.

They are most convenient to use too, because real big windows and white backgrounds permits entire fuse strip to be seen. Even in poor light a blown BUSS fuse is easy to find.

If you want to make safe protection REMAIN SAFE as well as REDUCE blowing fuses . . .

Use BUSS Fustats (have Type S base)

FUSTATS like Fusetron Fuses have a dual-element and therefore, stop needless blowing — and they do more.

They have a type S base that prevents anyone from replacing them with a penny or substitute — or using a size too large to protect.

FUSTATS fit standard plug fuse holders by means of an inexpensive adapter that locks in place and needs never to be replaced.

If you want to reduce blowing of Plug Fuses . . .

Use FUSETRON dual-element Plug Fuses

FUSETRON Plug fuses protect like ordinary fuses against short-circuits and overloads — but unlike ordinary fuses they won't blow on motor starting currents or other harmless overloads.

They are the type of fuses recommended in the 1953 National Electrical Code.

To protect motors and apparatus of voltages up to 125 against burnout . . .

Use 0 to 14 amperes BUSS Fustats

A FUSTAT of the proper size installed to handle only the motor current will reduce to a minimum the chance of a motor burnout from an excessive over-current. In like manner it will protect solenoids, coils and transformers against burnout.

FUSTATS have the same degree of Underwriters' approval for both motor-running and short-circuit protection as the most expensive devices made. They give all the protection it is possible to obtain with any device on the market.

FUSES! . . . THE SAFEST AND MOST DEPENDABLE PROTECTION YET DEVISED!

A fuse has just one vital part — a thin narrow strip of fuse metal. When the heat of a short-circuit is applied, the fuse link must melt and open the circuit.

The high speed operation of the fuse reduces to a minimum the danger of short-circuit damage to wiring and equipment.

Fuses offer dependable protection over the years.

The fuse link is sealed in. Dust can't get at it. Corrosion or oxidation can't increase its capacity or lengthen its blowing time.

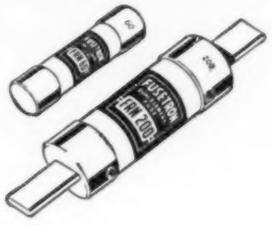
There are no hinges, pivots or contacts to stick or get out of order.

Millions of fuses have been in operation 30 years or more, because there has been no trouble on the

Play Safe! Install BUSS Fuses or

If you want fuses that — abolish all needless blows, stop overheating in panels and switches, protect motors against burnouts . . .

Use FUSETRON dual-element Fuses



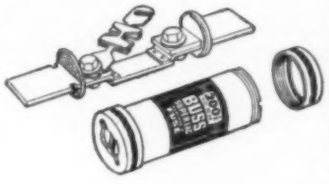
With rare exceptions, ordinary fuses or circuit breakers do not protect except against short-circuit but FUSETRON fuses provide TEN POINT protection.

1. Protect against short-circuits.
2. Protect against needless blows caused by harmless overloads.
3. Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.
4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.
5. Protect motors against burnout from overloading.
6. Protect motors against burnout due to single phasing.
7. Give DOUBLE burnout protection to large motors — without extra cost.
8. Make protection of small motors simple and inexpensive.
9. Protect against waste of space and money — permit use of proper size switches and panels.
10. Protect coils, transformers and solenoids against burnout.

FUSETRON duel-element FUSES save you time and money because they are made to PROTECT — not to blow.

If you want Renewable Fuses . . .

Use BUSS Super-Lag Renewable Fuses



The big advantage of these fuses over all other renewable fuses comes from the prevention of useless interruptions of service caused by needless blows.

The reason for this performance is found in the design of the fuse-case which assures good contact on the fuse link, even if the fuse is renewed by an inexperienced person — and by the time-lag built into the link that prevents the fuse from opening on motor starting currents or other harmless overloads.

If you want SAFE protection on loads above 600 and up to 5000 amps . . .

Use BUSS Hi-Cap Fuses

On voltages up to 600, high speed operation on heavy shorts limits current to safe values. This minimizes damage to equipment and cuts down dangerous stresses on transformers.

For Short-Circuit Protection or when fast opening is desired . . .

Use BUSS Limitron Fuses

The extremely fast opening characteristics of these fuses prevent heavy short-circuit currents from building up under fault conditions.

If you want Non-Renewable Fuses . . .

Use BUSS One-Time Fuses

They save you time and trouble because they get the same engineering care in manufacture as do all products carrying the BUSS Trademark.

Every BUSS One-Time fuse can be depended upon to operate as intended under all service conditions.

For protection of TV, Radio, Instruments, Radar, Avionics and Electronic Equipment . . .

Use BUSS and FUSETRON Small Dimension Fuses

A complete line is available. Made in Dual-element (slow-blowing), Renewable and One-Time types in sizes from 1/500 ampere up.

And there is a companion line of BUSS Fuse Clips, Fuse Blocks and Fuse Holders to take them.

circuits they are protecting and therefore no occasion to open.

Yet, after years of inactivity, you can be sure the fuse will give the same safe, dependable protection if called upon to open as it would have on the day it was installed.

NO RECALIBRATION COSTS

When Fusetron fuses do blow, there is no recalibration needed. As quickly as the fault in the circuit is corrected, you slip in a new fuse that has been CALIBRATED AT THE FACTORY BY ENGINEERS — a fuse that is as safe and dependable as the one that blew.

FOR MORE INFORMATION ON BUSS AND FUSETRON FUSES WRITE TO BUSSMANN MFG. DIVISION McGRAW-EDISON CO. ST. LOUIS 7, MO.

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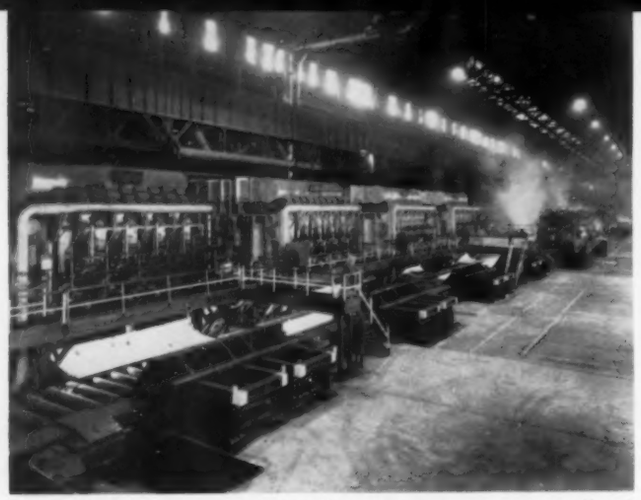

Figure 5—Four new slab heating furnaces serve the No. 2 hot strip mill. Each furnace has a rated capacity of 135 tons per hr.

Figure 6—Part of the cold mill expansion program includes this continuous slitter which trims and slits finished rolled coiled steel at 1,500 fpm. This addition to the cold mill facilities recently went into operation.

(*Continued from page 183*)

scheduled for completion in the spring of 1958 is the new 7200-ton per day sintering Plant No. 2.

At the Steel Plant since 1952, five additional open hearth furnaces were enlarged to 500 tons capacity to make a total of 14 furnaces at 500 tons capacity, two furnaces at 250 tons, and one 300 ton furnace.

New No. 2 mixer and Bessemer converter plant was installed with two 25-ton converters, a 1300-ton hot metal mixer, a bottom house and a blower house to serve No. 2 open hearth shop.

No. 2 mold yard was extended 358 ft and a new 50-ton crane provided.

A new skullcracker with 50-ton crane was put into operation.

A new 100-ton per day, 99.5 per cent purity oxygen plant was installed with provision for high-pressure storage.

A complete new 45 x 90-in. two-high reversing slabbing mill was installed with two 37 x 96 in. vertical edging rolls for rolling slabs $2\frac{3}{4}$ to 12 in. thick from 20 to 78 in. wide. All slabs are hot scarfed. The installation included a new slab yard, new motor room, comfort station and office building, and the new No. 2 soaking pit building. Ten blocks of four pits each were installed—each block is 8 ft 6 in. wide by 25 ft 0 in. long by 12 ft 9 in. deep—having a total capacity of 280,000 tons per month. The pits are coke oven gas fired.

Four new slab heating furnaces for No. 2 hot strip mill were installed, with a rated heating capacity of 135 tons per hour each.

The new No. 4 continuous pickling line for handling strip up to 78 in. wide and a maximum speed of 500 fpm was put into operation.

Expansion in the annealing department saw the installation of ten additional 8-stack, 60-in. diam coil annealing furnaces, seven 4-stack, 60-in. diam coil annealing furnaces, and 46 single stack coil annealing furnaces for 72 in. diam by 200-in. high coil stacks, increasing the annealing capacity to 170,000 tons per month. Included in this installation was the necessary instrument room, DX gas equipment and ventilation equipment.

The cold mill expansion program included one new skin pass mill, speeding up two skin pass mills, and installing new coil feeding and processing equipment; one new 3000 fpm, re-wind line; one new 1500-fpm slitting line; and new coil handling equipment for the exit ends of three tandem mills.

A new machine shop, forge shop and car repair shop were built, with a general office for the maintenance department.

A new sanitary sewer system for the entire plant was installed and connected to the Wayne County sewerage system.

WALL TYPE

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ALSO AVAILABLE IN FLOOR TYPE

RUGGED
and ECONOMICAL TOO!

WHEN the space is hard to heat — such as a crane or locomotive cab, a pump house or small office — a GUYAN natural convection heater is the answer. It is a DEPENDABLE, LONG-LIFE HEATER consisting of corrosion-resistant aluminum chromium wire — wound on ceramic forms — and mounted within expanded steel housings.

GUYAN Heater Units are ruggedly built to stand the hard service that is customary in tough industrial applications. Available from 1,500 thru 7,500 watts for 110, 220, 440 volts DC or AC. Priced right — more economically than you might think — and lower than you can make your own. Write for complete information.

GUYAN MACHINERY CO.
LOGAN, WEST VIRGINIA

Guyan
HEATERS

HOT-METAL CARS

USS-DESIGNED

to your specifications

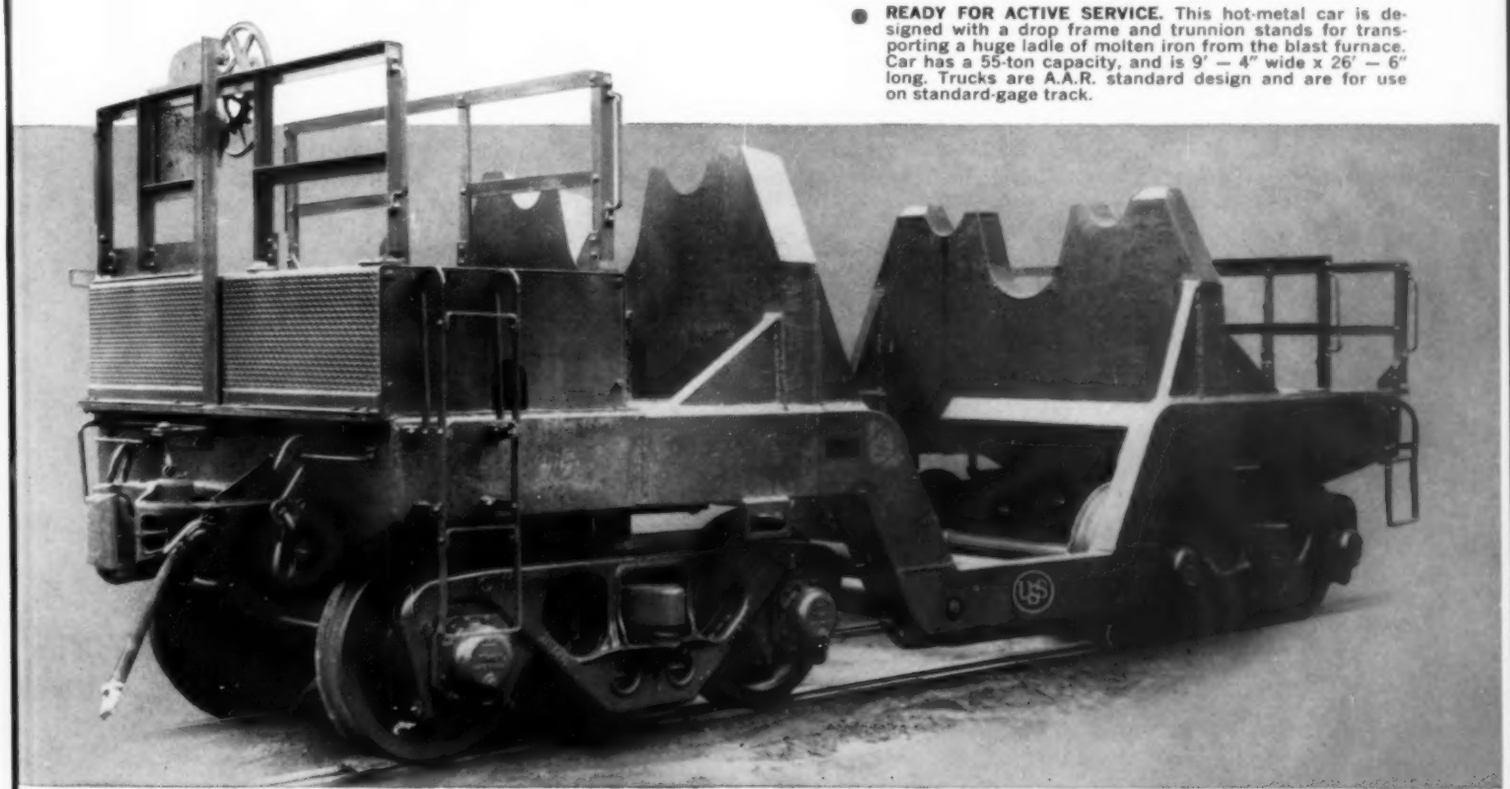
As you know, industrial cars come in many different types and sizes. And the type and size you need can be designed and built to your specifications by United States Steel.

A typical USS-Designed Car is shown here. It's a 55-ton hot-metal car having a drop frame and trunnion stands for transporting a huge ladle of molten iron from the blast furnace to the mixer. Car is fabricated from all-welded, rolled steel, and is properly stress-relieved. Side frames are six-inch rolled-steel plate, and the huge trunnion stands are eight-inch steel plate.

This car is equipped with air brakes for use in trains; it also has power hand brakes. Other variations are available in hot-metal cars. For example, cars can be designed to carry two pots, and they can be built with air-operated tilting mechanisms.

For information on many types of industrial cars, send for a free copy of our 32-page illustrated booklet—"USS Custom Designed Cars." And remember, you can call our engineers for consultation at any time convenient to you.

- **WELDING THE HOT-METAL CAR.** Car is fabricated from rolled steel. It is all-welded and subsequently stress-relieved for extra-heavy duty.
- **READY FOR ACTIVE SERVICE.** This hot-metal car is designed with a drop frame and trunnion stands for transporting a huge ladle of molten iron from the blast furnace. Car has a 55-ton capacity, and is 9′ — 4″ wide x 26′ — 6″ long. Trucks are A.A.R. standard design and are for use on standard-gage track.



USS INDUSTRIAL CARS

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALABAMA
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

United States Steel Corporation
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Please send me a free copy of your 32-page booklet, "USS Custom Designed Cars."

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SAFETY SWITCHES STAND UP UNDER 100,000 AMPERE SHORT CIRCUIT TEST!

INDEPENDENT TESTING LAB RELEASES FINDINGS AFTER GRUELLING "TORTURE RACK" TESTS

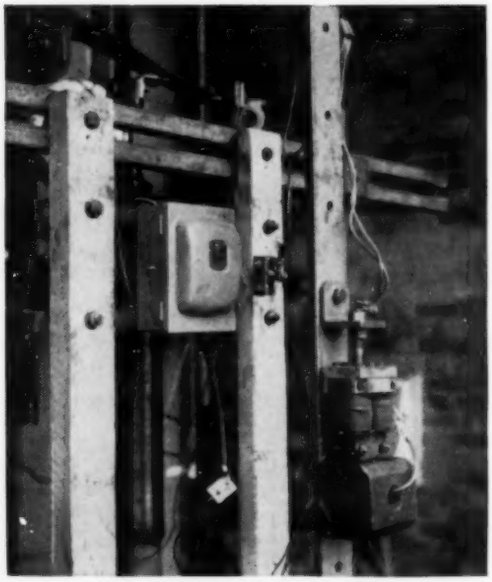
Unprecedented tests have been completed on 30 through 600 ampere rated Square D safety switches equipped with high capacity current limiting fuses. During these tests, switches were closed on a short circuit system delivering up to 100,000 amperes (symmetrical—R.M.S.). In addition, the fault was applied on the closed switches. *All switches withstood the shocks without any sign of failure!*

High Capacity Systems Demand Stamina

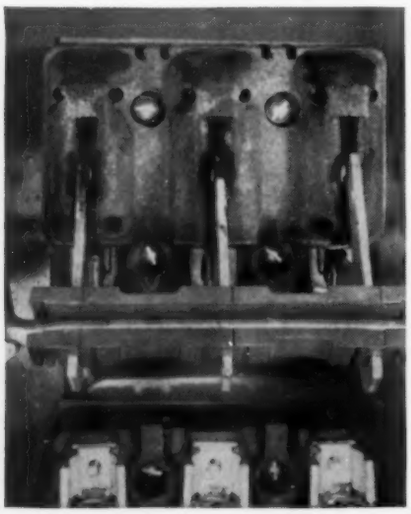
High capacity systems capable of delivering tremendous short circuits are becoming more and more prevalent with the growth of electrical loads. Network systems in metropolitan areas are a source of such faults. Another, the heavy industrial areas, with a concentration of sub-stations and rotating machinery. Terrific stresses and heat generated by such faults are serious hazards to both personnel and equipment unless properly contained. That is why proven protection for switching service and feeder circuits is of major concern.

Square D Standard Switches Do The Job

These tests offer conclusive proof that standard Square D Type HD and Type ND switches, equipped with high capacity current limiting fuses, can be used on such systems without fear of failure. You pay no premium for the proven performance they offer. Why settle for less?



Square D switch on "torture rack" during test involving up to 100,000 ampere short circuit



SUMMARY TABLE • Extract from Report No. S/NA R66—Sheet No. 5

Ampere Rating	Voltage Rating	Catalog Number	Average Symmetrical Prospective Current R.M.S.	Recovery Voltage R.M.S.	Maximum Total Arcing Time	Fuse Type
30	250	A85351	96,600	252	.0009	A2Y-30A
30	250	A85351	96,400	253	.0010	FRN-30A
30	600	A85341	107,000	590	.0020	A6Y-30A
30	600	A85341	106,000	601	.0027	FRS-30A
60	250	A86352	96,400	248	.0010	A2Y-60A
60	250	A86352	95,200	252	.0019	FRN-60A
60	600	A86342	106,000	605	.0011	A6Y-60A
60	600	A86342	108,000	598	.0020	FRS-60A
60	600	A86342	107,000	601	.0013	NAS-60A
100	250	A86353	95,200	253	.0009	A2Y-100A
100	600	A86343	108,000	604	.0014	A6Y-100A
200	250	A86354	95,200	253	.0037	A2Y-200A
200	600	A86344	107,000	602	.0011	A6Y-200A
400	250	A86355	95,900	252	.0039	A2Y-400A
400	600	A86345	106,000	611	.0050	A6Y-400A
600	250	A86356	94,500	251	.0062	A2Y-600A
600	600	A86346	107,000	601	.0062	A6Y-600A

Above **• Extract of Nelson High Power Laboratory Report C/NA-66**

At left **• No sign of failure in this switch interior after 100,000 ampere short circuit test**

SQUARE D SAFETY SWITCHES GIVE YOU *Certified* PERFORMANCE!

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY

New Rolling Mill Boosts Capacity at Latrobe Steel

▲ IN recent years, more and more steel plants are turning out products which are not steel at all. One of these is Latrobe Steel Co. at Latrobe, Pa. Over the past 44 years this company has built up a fine reputation for high grade high-speed steels and, more recently, special alloys that contain little or no iron.

The recent installation of a new rolling mill has boosted processing capacity of the plant and made possible better working of the hardest steels and super alloys. This mill was designed by Latrobe Steel to fit the problems imposed by these special products.

The mill is a 32-in., two-high reversing unit using diagonal pass rolls with a short bull-head pass. It will reduce ingots ranging from 300 lb (7-in. square) to 4000 lb (18-in. square) down to squares as small as 3 in. or to flats up to 12 in. wide.

The mill is driven by a 1400-hp, 600-volt, 190-rpm d-c reversing motor under adjustable voltage control. This drive motor receives power from a 1500-kw, 550-volt d-c generator driven at 514 rpm by a synchronous motor rated at 1875 kva, 4600 volts.

Motor-operated side guards on both sides of the mill handle the ingot during rolling, placing it in the proper pass line. Three grooved feed rollers on each side of the mill guide the ingot into the passes. Mill screws are operated by two d-c motors.

As might be expected, reductions in each pass are much smaller than in the usual rolling process, running only two to eight per cent with the hardest products, and possibly to 10 or 12 per cent on the softer ones. A production of 100 tons per eight-hour turn might be considered normal.

Diagonal rolling in diamond passes provides more uniform working of the metal throughout the entire section, avoiding the chance of rupture in the center of the hard alloys.

Ingots to be rolled on the 32-in. mill are heated in a continuous natural gas fired car-type furnace approximately 100 ft long. This furnace is divided into ten control zones and holds ten cars. Each car has a baffle wall at one end, so that the train of cars in the furnace is practically ten separate compartments, permitting each carload to be heated in the particular temperature cycle and range required by the material on that car.

Sixteen portable covers, also fired with natural gas, are used for preheating ingots before charging into the furnace and for slow-cooling of materials requiring it.

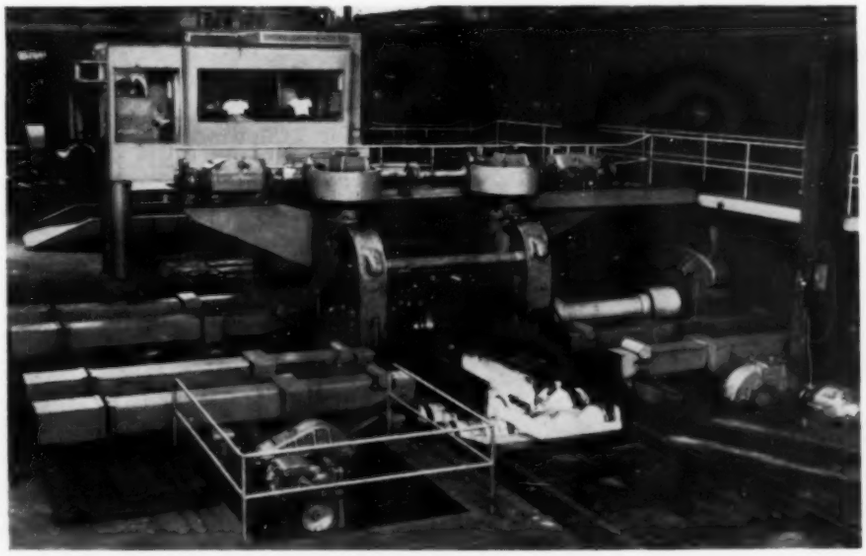
Some materials, with very narrow working temperature ranges, require intermediate heating during the rolling process. A batch-type furnace is available for such reheating.

Heated ingots are handled from the furnace to the mill by a mobile floor manipulator.

The mill and its allied equipment represents an investment of more than $3,000,000. Prior to its installation, Latrobe depended entirely on seven forging hammers (750 lb to 8 tons in capacity) for its roughing operations.

In addition to ingots produced in the company's own electric arc furnaces, the new mill rolls ingots shipped in from other producers. The previously existing bar mills are used for rerolling to the smaller sizes. Finishing equipment in the plant includes cold drawn benches, wire drawing blocks and centerless grinding facilities.

Figure 1 — Latrobe's new 32-in. cogging mill features grooved feed rollers, and diagonal pass rolls. Mill is driven by 1400-hp, d-c, reversing motor.



MEMO
How can we get tighter joint assemblies in our electrode columns?
MEMO
Let's get in touch with Great Lakes Carbon--they've always been helpful, and their product performance is outstanding!

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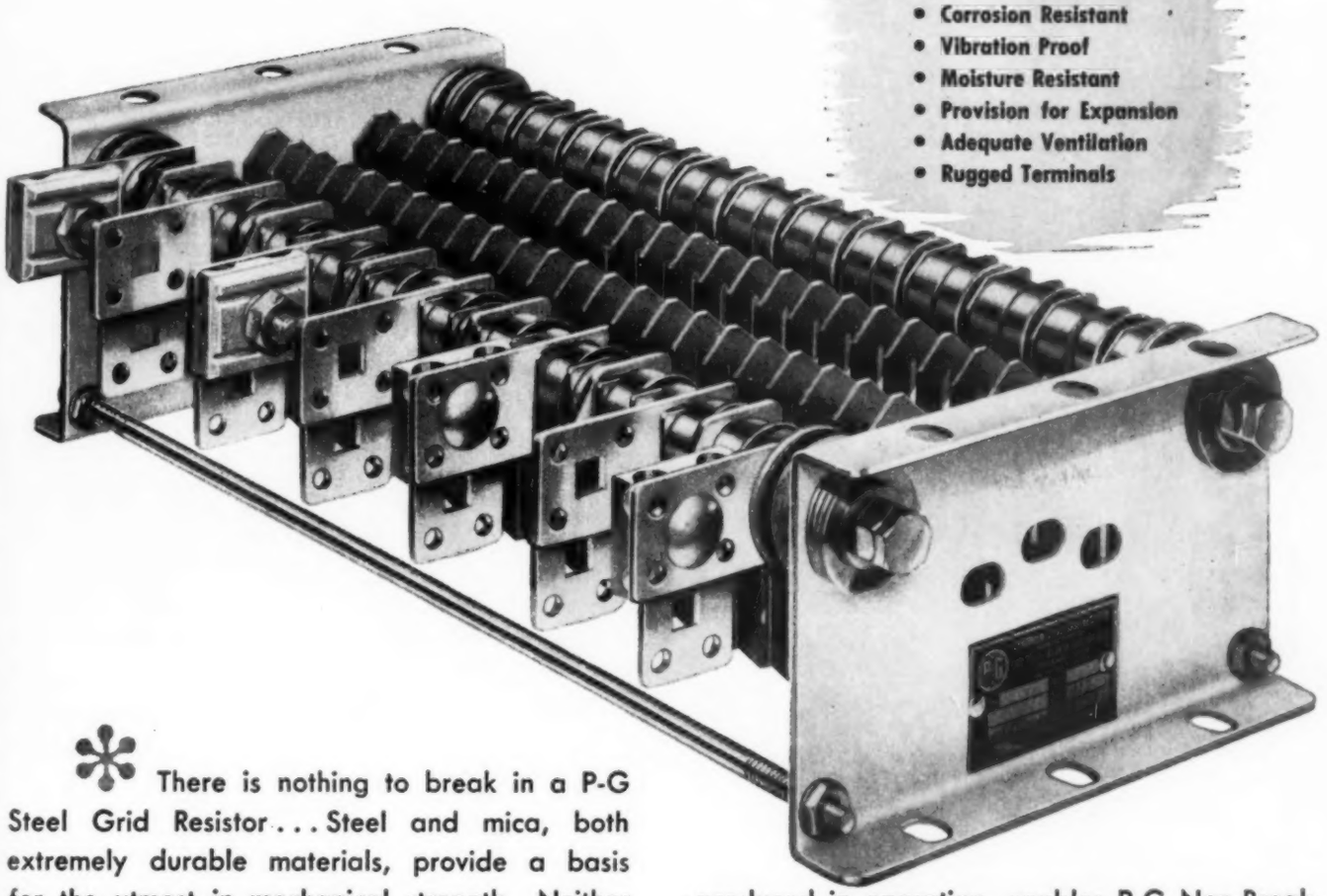
GREAT LAKES CARBON CORPORATION

18 EAST 48TH STREET, NEW YORK 17, N.Y. · OFFICES IN PRINCIPAL CITIES

BUILT OF *Steel* AND *Mica*

NOTHING TO BREAK . . .

- Steel Construction
- Mica Insulation
- Corrosion Resistant
- Vibration Proof
- Moisture Resistant
- Provision for Expansion
- Adequate Ventilation
- Rugged Terminals



There is nothing to break in a P-G Steel Grid Resistor . . . Steel and mica, both extremely durable materials, provide a basis for the utmost in mechanical strength. Neither do vibration, nor moisture laden or corrosive atmospheres have material effect on P-G Resistors . . . This, together with provision for expansion as well as efficiency in dissipating heat produced in operation, enables P-G Non-Breakable Resistors to give long and trouble-free service . . . The next time that troublesome application is at hand, specify P-G and solve your maintenance problem.

Write for Bulletin No. 500

The Nonbreakable Steel Grid Resistor

P-G

ESTABLISHED 1892

THE **POST-GLOVER** ELECTRIC COMPANY

OFFICE and FACTORY—Kenton Lands Road, Erlanger, Kentucky

MAILING ADDRESS—Box 709, Covington, Kentucky

The New One. Battery No. 9, installed by Koppers last year, consists of 41 Koppers-Becker underjet ovens capable of producing 700 tons of furnace coke a day.

Below, ovens are pushed on a fixed 17-hour schedule.

294 KOPPERS COKE O

THE NEW NO. 9 COKE BATTERY at Weirton Steel Company went into operation in November, 1956. These 41 Koppers-Becker underjet ovens and five previous batteries, all designed and built by Koppers, give Weirton a total coke-producing capacity of 1,900,000 tons per year.

There are good reasons why Weirton Steel Company, a division of National Steel Corporation, has always called on Koppers for coke plant design and construction. Koppers has been improving coke ovens since 1907—reducing operating costs, increasing the yield of chemicals, improving control of heating. These improvements can be measured in dollars—dollars saved where Koppers ovens are installed.

No Decarbonizing Equipment

Koppers-Becker underjet ovens eliminate the need for decarbonizing equipment because waste gas is recirculated to inhibit carbon formation in flues and in gas ducts. This also cuts fuel gas consumption.

KOPPERS

. . and another new battery makes

KE OVENS AT WEIRTON STEEL!

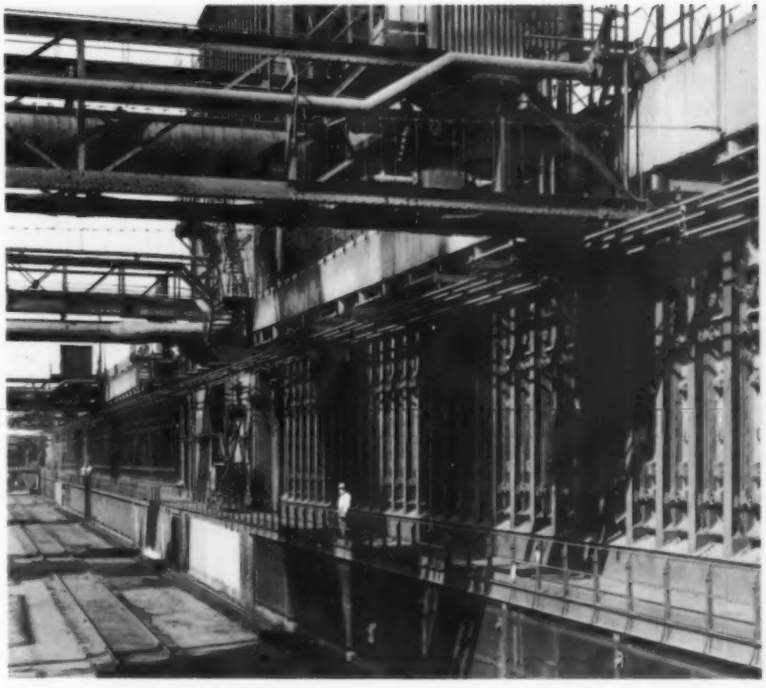
Koppers ovens provide unusually even coke temperature from top to bottom and from door to door. The result is extremely uniform coke.

Plant Layout and Design

Koppers research and engineering staffs can tailor designs and plant layouts to your needs . . . can help you with all problems connected with coal preparation and handling, coal-chemical recovery, light-oil refining and purification, phenol recovery, and other processes associated with coke plant operations.

• • •

Call Koppers for *any* type of steel-mill installation. Engineers from the Coke Plant Department, Freyn Department, and Chemical Department are prepared to work with you during all phases of plant construction, expansion, or rebuilding. Koppers Company, Inc., Coke Plant Department, Pittsburgh 19, Pennsylvania.

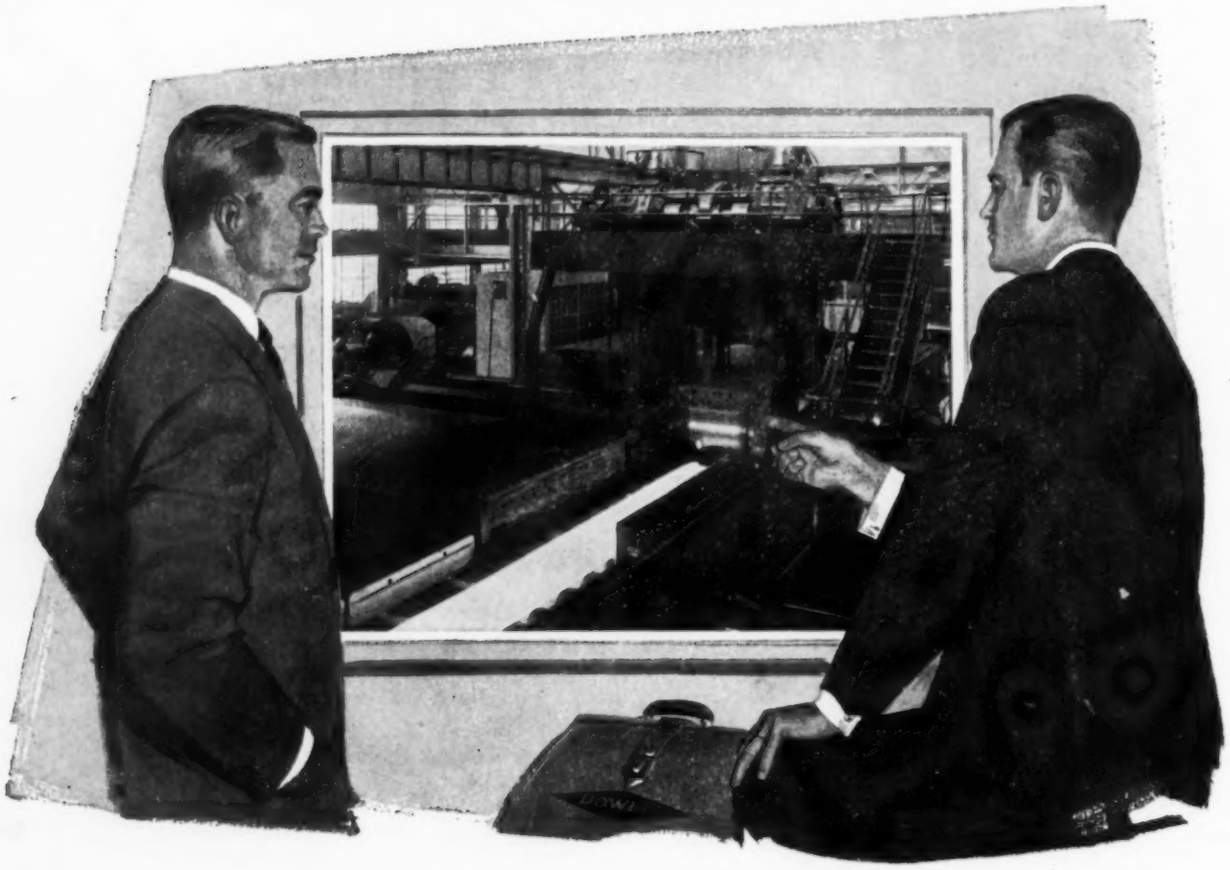


Weirton Ovens are 100% Koppers. Every coke oven built for Weirton Steel Company has been built by Koppers. In this photo are batteries 5, 6 and 8 . . . with 147 Koppers ovens in line.

KOPPERS

ENGINEERING AND CONSTRUCTION

A $250,000 operating credit made possible by Dowell mill scale removal service!



This operating credit was made possible when Dowell chemically cleaned a steel company's new rolling mill before it was put into operation. By removing mill scale thoroughly, Dowell Service prevented any major, emergency shut-down caused by scored bearings or fouled lines and valves. This netted the company an estimated $250,000 operating credit.

Following the erection of this new 45 x 80, 2-high slab mill, Dowell was called in to remove mill scale and degrease the lube oil system, hydraulic and air lines, hydraulic systems for the roll changer and vertical edger, and the Bowser lube oil systems in the main motor room.

The job was accomplished in about one-half the time it would have taken the steel company to do the work itself. The cost of Dowell Service was only $21,000.

In addition to reducing the risk of mill-scale fouling, Dowell Service eliminated the costly process of prepickling or batch pickling the pipe used in the hydraulic, lube oil and air line systems.

Dowell chemical cleaning service has made possible similar savings for many companies in other industries — such as chemical, refining, paper, and the public utilities. That's because Dowell engineers are experts in the use of solvents to remove scale and sludge from process equipment, tanks, piping and lines. Dowell furnishes all the necessary chemicals, trained personnel, pumping and control equipment.

For specific information on how chemical cleaning can help you to greater profits, call the Dowell office near you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

have Dowell clean it chemically **DOWELL**

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

November 1

▲ The AISI reports estimated payroll for the iron and steel industry for September, 1957, amounted to $330,076,000 compared with $343,730,000 in August, 1957. Estimated total employment was 650,800 compared with 663,100 during August. Average hourly payroll cost per wage earner was $3.022, compared with August cost of $2.990. Average hours worked a week was 36.4 compared with 36.5 in August. The estimated payroll for the first three-quarters of 1957 is a record $3,038,926,000.

▲ Westinghouse Electric Corp. reported a net income for the first 9 months of 1957 of $49,102,000 or $2.83 per common share on total sales were $1,477,273,000 compared with sales of $1,015,814,000, loss of $1,399,000 or $0.17 per share, for the same period of 1956.

November 4

▲ The New York Central and Pennsylvania Railroads announced they were considering plans for a merger of these two systems, and left the door open for other eastern roads to join them in studies looking forward to a far-reaching merger aimed at operating economies and improved service.

▲ The AISI reports that the operating rate of the steel industry for the week of November 4 is scheduled at 78.7 per cent of capacity. This is equivalent to 2,015,000 tons compared with 2,041,000 tons one week ago and 2,463,000 tons one year ago. Index of production for the week is 125.4.

November 5

▲ According to the F. W. Dodge Corp., contracts for future construction in the United States totaled $2,624,928,000 in September, 1957, a gain of two per cent over September 1956. The prediction for construction in 1958 is a total of $33,830,000,000, a gain of five per cent over the expected 1957 level.

▲ Armco Steel Corp. announced it plans to acquire the business and assets of the Union Wire Rope Corp., of Kansas City, Mo., subject to the approval of the stockholders of the Union Wire Rope Corp. Boards of directors of both companies have approved the proposed transaction, under which Union Wire Rope would receive Armco stock on the basis of 2½ common shares of Union Wire Rope for one share of Armco.

▲ The Bureau of Mines, U. S. Dept. of the Interior, reported that the October, 1957 production of Pennsylvania anthracite amounted to 2,162,000 net tons, compared with 2,185,000 net tons in September, 1957 and 2,971,000 net tons in October, 1956.

November 6

▲ Columbia-Geneva Steel Division of the U. S. Steel Corp. announced closure of two of its 10 open hearth furnaces, and reduction of structural steel rolling mill operations from five to four days weekly.

▲ Sharon Steel Corp. reported a curtailment in pig iron output due to substantial built up inventory.

▲ The AISI reported that shipments of finished steel products for September, 1957 totaled 6,171,674 net tons compared with 6,229,853 tons in August, 1957 and 7,058,028 net tons during September, 1956. Shipments of finished steel products for the first nine months of 1957 totaled 62,589,328 net tons, an increase over this period of 1956 of 1,700,000 tons.

November 7

▲ Copper prices were increased by custom smelters to 26 ¢ per lb, up ½ ¢. The increase followed an upturn in spot copper at London to 24.43 ¢, a recent increase of over 1 ¢.

▲ Commerce and Labor Depts. reported that construction outlays for 1957 will reach $47,000,000,000 based on the basis of 10-month building expenditures.

▲ Federal Judge Edward Weinfeld reserves decision in government case to block merger of Bethlehem Steel and Youngstown Sheet and Tube, granting the government ten more days to file replies to the company's original affidavits, and an additional two weeks to company attorneys to file briefs on material they would use in event of a trial.

▲ Crucible Steel Company of America stockholders authorized 101,153 shares of new preferred stock to be issued at $100 per share par value. Offering of stock is being delayed for more favorable market conditions.

November 8

▲ The directors of American Metal Co. and Climax Molybdenum Co. approved a merger of the two companies, subject to vote of the stockholders on December 30. Operation of the merged company will be under the name of American Metal Climax, Inc.

November 11

▲ Commerce Dept. reported that inventory accumulation by business slowed in September, 1957. On a seasonally adjusted basis stocks increased about $100,000,000, only about 50 per cent of the average gain of earlier months.

▲ Stockholders of Superior Steel and Copperweld Steel approved the merger of the two companies to be accomplished by exchange of three-fourths of a share of Copperweld common for each share of Superior.

▲ Anaconda Co. (Canada), Ltd. has purchased the iron ore mining claims and properties of the Lake Superior Iron Ore Co. Ltd., and the Jean Courd et al syndicate mining claims and properties for $10,000,000.

▲ The AISI reports that the operating rate of the steel industry for the week of November 11 is scheduled at 77.5 per cent of capacity. This is equivalent to 1,984,000 tons compared with 1,996,000 tons one week ago and 2,466,000 tons one year ago. Index of production for the week is 123.5.

November 12

▲ Crucible Steel Co. of America announced it has acquired full ownership of Rem-Cru Titanium, Inc., in exchange for 150,000 shares of Crucible Steel stock from Remington Arms for its half interest in Rem-Cru Titanium, Inc.

▲ The National Machine Tool Builders' Assn. reported that shipments for the first 9 months of 1957 totaled $679,100,000, new orders equaled about $445,000,000. In the same period of 1956, shipments totaled $629,500,000, new orders $736,450,000. Backlog on January 1, 1957 represented about 6.2 months output, on September 30, 1957 the backlog amounted to about 3.7 months production.

November 13

▲ The AISI reports that the steel industry for the month of October, 1957 produced 9,195,000 net tons

(September 1957 was 8,977,906 net tons), operated at 81.1 per cent of capacity, and index of production of 129.3. For the first 10 months of 1957, production of ingots and steel for castings equaled a record 96,899-075 net tons, operated at 87.2 per cent of capacity, and index of production at 138.9. For the same period in 1956, production amounted to 93,823,104 net tons.

November 14

▲ Price of custom copper, losing its recent gain, dropped ½ ¢ a lb, back to 25½ ¢ a lb.

▲ Steel scrap prices in Philadelphia declined further, off $1 a ton, with No. 1 heavy melting steel being quoted at $34.50 a ton.

November 15

▲ Final loadings of iron ore vessels on the Great Lakes are set for the last week in November due to high side ore inventories at mills.

November 18

▲ The AISI reports that the operating rate of the steel industry for the week of November 18 is scheduled at 76.8 per cent of capacity. This is equivalent to 1,965,000 tons compared with 1,990,000 tons one week ago and 2,463,000 tons one year ago. Index of production for the week is 122.3.

▲ B. E. Estes, director-staff administration of the U. S. Steel Corp., in a Chicago speech, predicted that steel production for 1958 would total about 109-000,000, about 5 per cent off 1957 production which is expected to approximate 115,000,000 tons.

▲ The Federal Reserve Board reported that industrial production rate in October, 1957 amounted to 142 per cent of the 1947–49 average, two points below September, 1957, and four points down from October, 1956.

▲ The Commerce Dept. reported that personal income, adjusted to a seasonally adjusted annual rate, declined to $345,500,000,000, down $1,000,000,000 from September, 1957, but $11,500,000,000 higher than October, 1956.

November 19

▲ The ARCI reports that deliveries of new domestic freight cars in October, 1957 totaled 8,295 compared with 8,450 in September, 1957, and 5,666 in October, 1956. Orders totaled 2,206 compared with 3,257 in September, 1957 and 6,532 in October, 1956. Backlog of cars on order as of November 1 stood at 65,718 cars compared with 71,981 a month earlier.

▲ Northeastern Steel became a Carpenter subsidiary today. The date for appealing U. S. District Court order expired, confirming Carpenter's purchase of Northeastern.

November 20

▲ The Aluminum Assn. reported primary aluminum production in the United States during October, 1957 was 133,759 short tons compared with 129,277 short tons in September, 1957 and 149,125 tons in October, 1956.

▲ Industrial Heating Equipment Assn. reports that new orders of industrial furnaces in October, 1957 were $3,621,000, compared with $8,740,000 in October, 1956; orders for induction and dielectric heating equipment in October were $385,000 compared with $1,468,000 in October, 1956.

▲ World Bank and nine U.S. and Canadian commerical banks granted a $32,500,000 loan to Tata Iron & Steel Co., Ltd., of India, for 13½ years, to aid in financing a 5-year plan of expanding the company's steel ingot capacity to 2,000,000 tons annually up from the 1,100,000 tons in operation in 1950.

November 21

▲ American Telephone plans to offer $720,000,000 convertible debentures to stockholders early in 1958, to meet the demands for new telephone facilities.

November 22

▲ Rail freight traffic last week fell 15.3 per cent below the same period in 1956. The Assn. of American Railroads cited the slump was accentuated by a substantial falling off in iron ore loadings.

▲ Copper prices were reduced ½ ¢, to 25 ¢ a lb by custom smelters.

November 25

▲ Universal-Cyclops Steel Corp. plans to acquire Empire Steel Corp. and Reeves Steel and Manufacturing Co. through an exchange of stock.

▲ Bookings for machine tools amounted to $27,800-000 in October, 1957, down 3.3 per cent from September, 1957 and 58 per cent from October, 1956.

▲ A revised pension plan which calls for increased minimum pension benefits in the case of both normal and disability retirements and contains such important innovations as provision for early retirement and for vested pensions under certain conditions, became effective November 1, according to the terms of an Agreement between Weirton Steel Co. and Independent Steelworkers Union.

▲ The AISI reports that the operating rate of the steel industry for the week of November 25 is scheduled at 73.6 per cent of capacity. This is equivalent to 1,884,000 tons compared with 1,945,000 tons one week ago and 2,489,000 tons one year ago. Index of production for the week is 117.3.

November 27

▲ Pittsburgh Steamship division of U.S. Steel Corp. plans construction of 12 new Great Lakes ore boats, involving an outlay of about $100,000,000.

November 29

▲ The AISI reports that shipments of finished steel products to the oil and gas industry in 1957 are estimated at 7,000,000 net tons, compared with 5,600,000 tons in 1956.

▲ The AISC reports that shipments of fabricated structural steel for October, 1957 were 330,950 tons compared with 294,719 tons in September, 1957 and 287,639 tons in October, 1956. Bookings for October 1957 amounted to 177,178 tons compared with 194,228 tons in September, 1957 and 290,961 tons in October, 1956. Backlog on October 31 equaled 2,683,262 tons, approximately 17 per cent under a year ago.

▲ According to the F. W. Dodge Corp. construction contracts in the United States for October, 1957 amounted to $2,613,791,000, an increase of 7 per cent over October, 1956.

▲ Phoenix-Rheinrohr A. G. of Duesseldorf, West Germany reports sales of $388,095,244 for the fiscal year 1956/1957 ended September 30, compared with $333,800,000 in 1955/1956.

▲ Nation's rail carriers will seek repeal of the three per cent Federal excise tax on freight shipments in a program they will present to the Administration and Congress soon.

▲ The Bureau of Mines reported that the consumption of scrap during September, 1957 totaled 5,034-000 gross tons, pig iron used was 5,646,000 gross tons compared with 5,299,543 tons of scrap and 5,769-995 tons of pig iron in August, 1957.

▲ The Aluminum Assn. reported that shipments of aluminum sheet and plate in October, 1957 totaled 105,254,000 lb, compared with 96,054,000 in September, 1957; shipments of aluminum foil in October, 1957 amounted to 17,238,609 lb, in September 1957 shipments were 15,399,121 lb.

MAKE SURE YOUR NEXT BULK MATERIALS HANDLING UNLOADER HAS THESE IMPORTANT DRAVO FEATURES:

- Liberal Use of Welded Components
- Double Web Truss System with Beam Sections
- Positive Wind Protection with Dravo Rail Clamps
- Fully Equalized Loading on Truck Wheels
- Use of Unit Construction for Mechanical Elements
- TROLLEY ACCIDENT PREVENTION WITH DRAVO HYDRAULIC BUFFERS

These six-foot stroke hydraulic buffers, installed on end of unloader span, provide safe stop for a 120-ton man trolley traveling at 900 feet per minute.

DRAVO Unloaders...

Hydraulic Buffers Stop Trolley Safely at any Speed

The use of hydraulic buffers is one example of how Dravo builds efficiency and safety into unloaders. Operators work more efficiently when safety is assured by smooth, hydraulic-buffered stops. In fact, every Dravo unloader is individually designed to handle its specific job not only safely, but also dependably and economically. Such performance is made possible by bringing together the customer's operating knowledge and the experience of Dravo's research, design and construction men.

This method has resulted in high efficiency unloaders and other bulk materials handling equipment that produce because they are tailored to fit the job. Dravo engineering features, built into every structure, provide for low maintenance and operating costs. For complete information on Dravo unloaders and ore bridges, write to Dravo Corporation, Pittsburgh 25, Pa.

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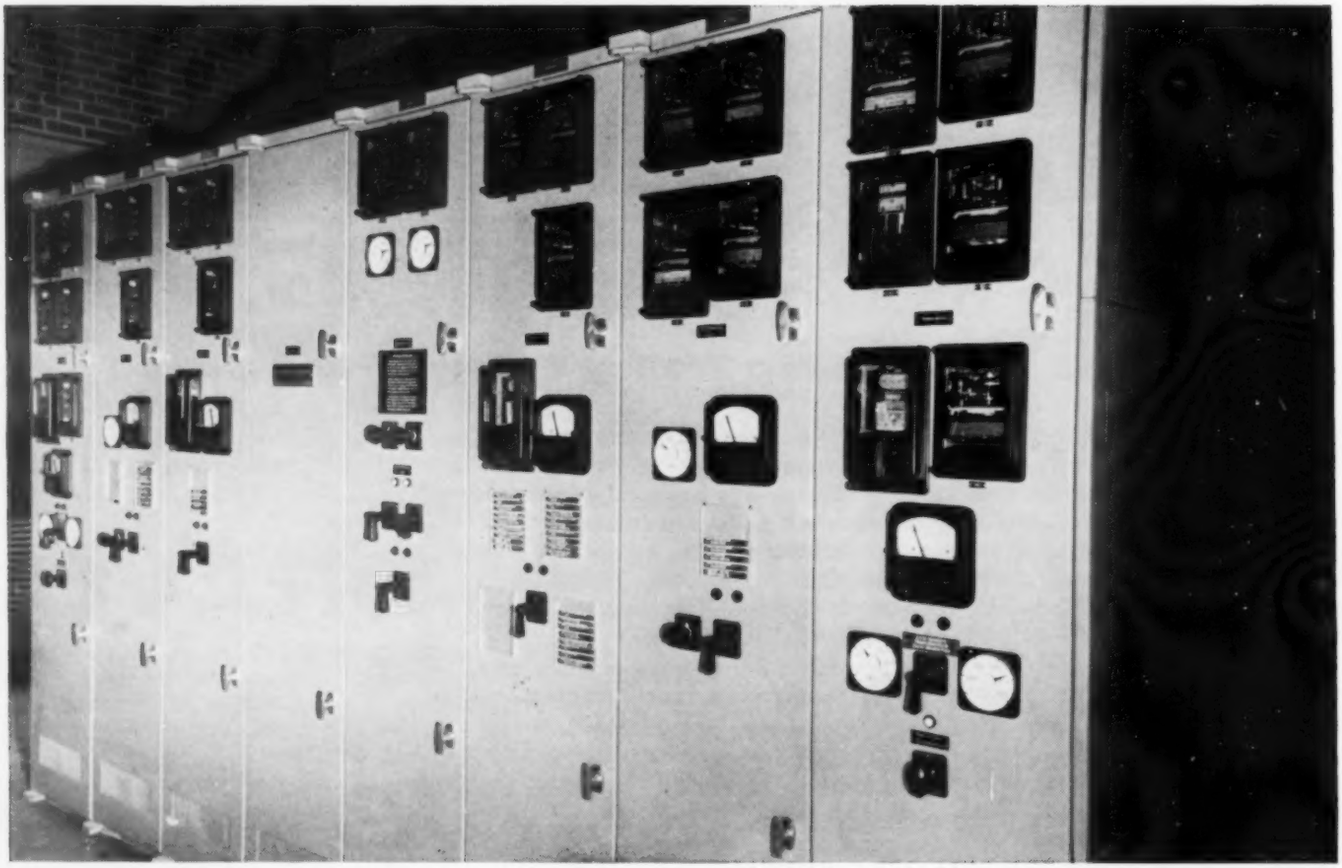
Blast furnace blowers • boiler and power plants • bridge sub-structures • cab conditioners • docks and unloaders • dredging • fabricated piping foundations • gantry and floating cranes • gas and oil pumping stations • locks and dams • ore and coal bridges • process equipment • pumphouses and intakes • river sand and gravel • sintering plants • slopes, shafts, tunnels • space heaters • steel grating • towboats, barges, river transportation

First 5 kv Breaker in

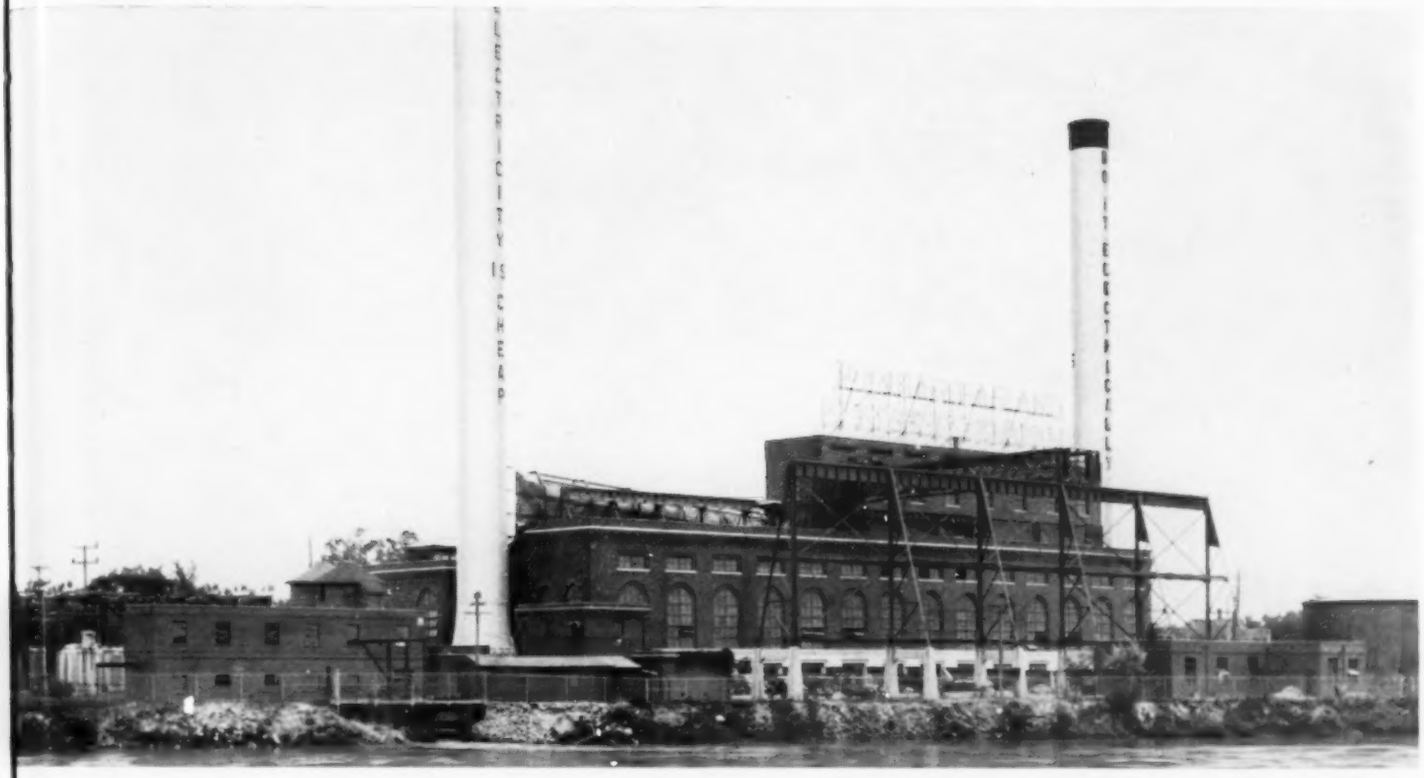
I-T-E leads again. Three installations already. More coming soon.

First 350 mva air magnetic circuit breakers to be developed in the 5 kv class. First to be installed. First to be operating. This latest electrical progress reflects I-T-E's constant effort to extend the ratings of modern metal-clad switchgear. And as with all I-T-E equipment, these new circuit breakers are made with I-T-E's traditional emphasis on sound engineering and quality construction. Available now in 1200 and 3000 amp continuous current ratings. Write for technical details on your specific application.

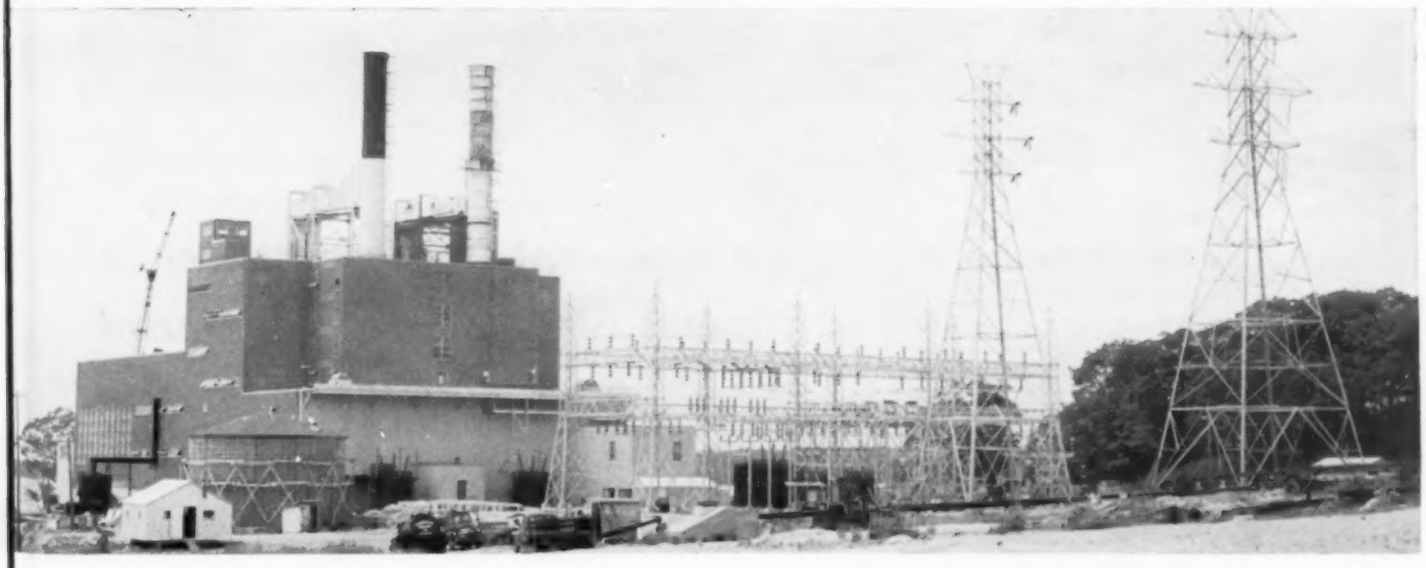


Installation at Esso Standard Oil Co., Baton Rouge, La.

350,000 kva Rating



Kansas Gas and Light Co., Wichita, Kans.



Central Maine Power Co., Augusta, Maine

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SWITCHGEAR DIVISION

I-T-E CIRCUIT BREAKER COMPANY

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Specify... **J-M Asbestos Wick** **J-M Asbestos Rope**

Wherever you need general utility packings that are easy to handle, highly heat resistant

Throughout the iron and steel industries, the list of uses for Johns-Manville Asbestos Wick and Rope is constantly growing. These soft, resilient, heat-resisting materials are widely employed for general packing, gasketing and caulking applications.

In coke ovens, both are used to caulk around the doors to prevent the escape of gases. Asbestos Rope (Style 4200) also serves as expansion joint material in the brickwork.

Only a few of the many applications for Asbestos Wick (Style 4202) can be given here. It seals hot metal in the ingot mould, around the top and between the mould and the stool. It gives protection from burning to water hoses that cool Open Hearth doors. It serves as a seal between the cope and drag on moulding flasks. It is used to wipe excess coating from wires after passing through the galvanizing bath.

Styles 4200 and 4202 are made from pure asbestos fibre carefully controlled for quality at Johns-Manville's own mine and mill (largest in the world). Asbestos Rope is formed by twisting together two or more strands of Wick to obtain the desired thickness. For further information, call your local J-M distributor or write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

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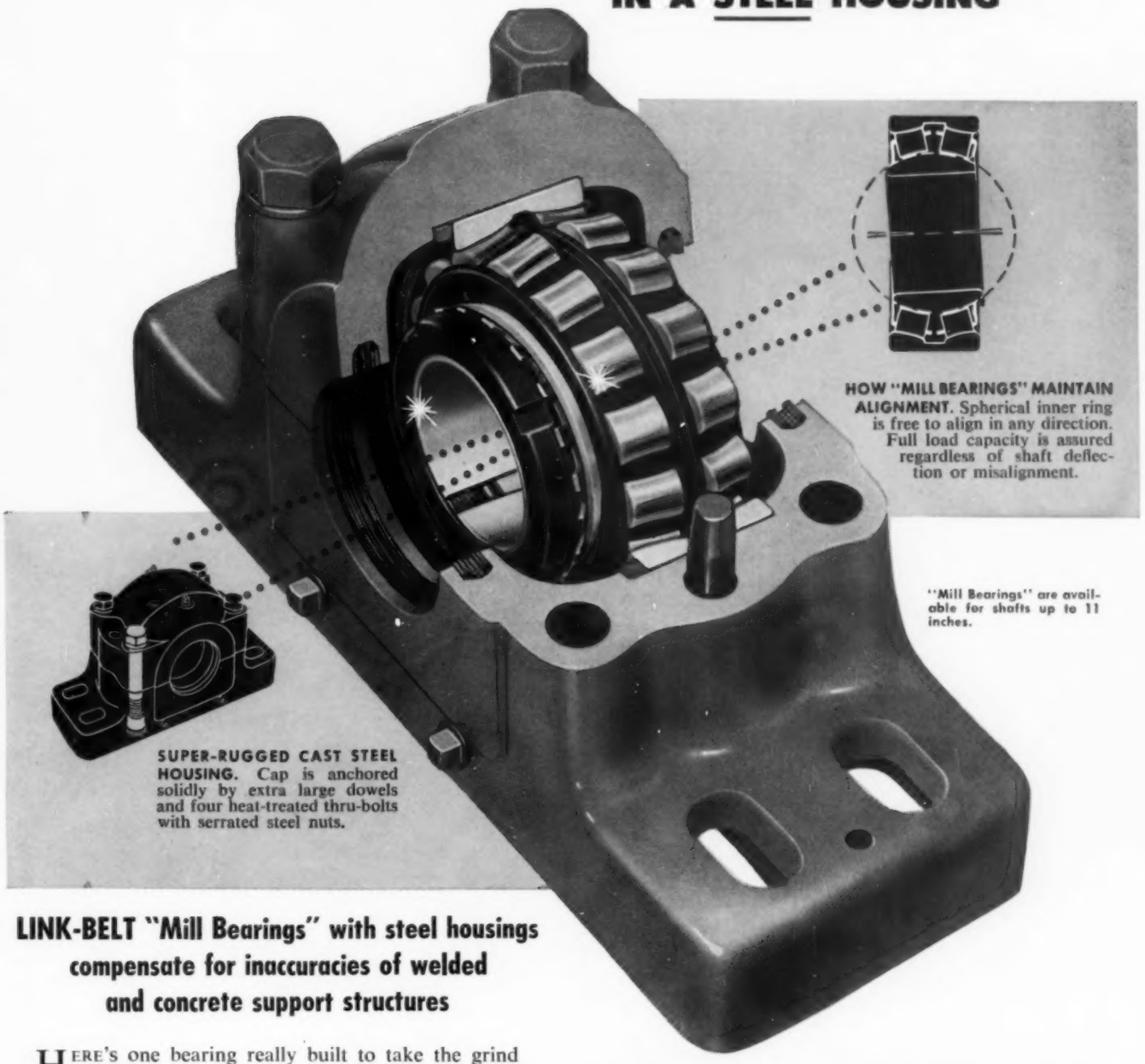
JM PRODUCTS

HERE'S self-alignment

IN A STEEL HOUSING



HOW "MILL BEARINGS" MAINTAIN ALIGNMENT. Spherical inner ring is free to align in any direction. Full load capacity is assured regardless of shaft deflection or misalignment.

"Mill Bearings" are available for shafts up to 11 inches.

SUPER-RUGGED CAST STEEL HOUSING. Cap is anchored solidly by extra large dowels and four heat-treated thru-bolts with serrated steel nuts.

LINK-BELT "Mill Bearings" with steel housings compensate for inaccuracies of welded and concrete support structures

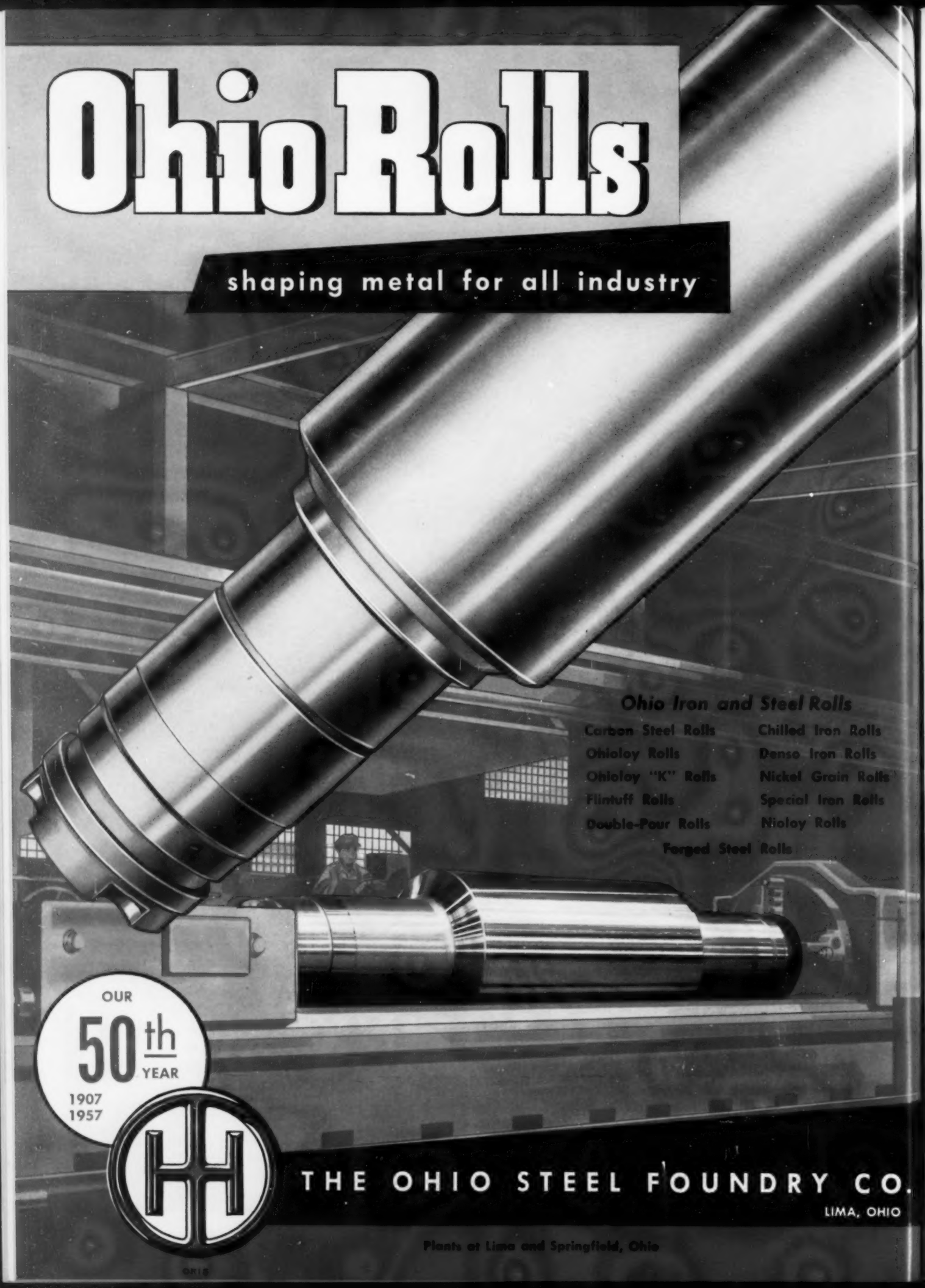
HERE'S one bearing really built to take the grind and grime of heavy loads in steel mills, mines, foundries and other extra-severe applications. The self-aligning Link-Belt "Mill Bearings" with cast steel housing adjust for misalignment of shafts and support structures. Furthermore, it eliminates the need for extra heavy shafting to avoid deflections which are ruinous to ordinary bearings.

This bearing is effectively sealed, self-contained, factory-adjusted—needs no shims or alignment rings at installation. Get full facts in Book 2565A . . . or Book 2550, which covers industry's most complete line of self-aligning ball and roller bearing blocks. Ask any of the 40 Link-Belt offices or your authorized stock-carrying distributor. 14,442

LINK BELT

self-aligning ball and roller bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.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Industry News...

INLAND ORE BRIDGE TO BE BUILT BY WELLMAN

▲ Wellman Engineering Co., Cleveland, a subsidiary of McDowell Co., Inc., has been awarded the contract for a new ore bridge for Inland Steel Co.'s Indiana Harbor Works, it was announced.

The new bridge is a duplicate of Inland's No. 9 bridge, which went into operation earlier this year, and when installed it will be used to increase Inland's ore handling capacity to the level required by a new ore screening and sintering plant, which is under design by the Dwight-Lloyd Division of McDowell Co., Inc.

Construction crews for the parent firm started work for the new sintering plant facility on November 1, 1957, with completion scheduled for early 1959. The new sintering plant will be installed on a 20-acre site presently being prepared. The Wellman fabricated sintering machine, designed to produce an initial capacity of 4000 tons per day of sinter product, and engineered to handle up to 6000 tons a day, will supply six of Inland's blast furnaces with a beneficiated burden. The improved charge of screened ore and sinter is expected to make a substantial improvement in the iron-making capacity of the plant.

The Inland plant is the fourth turnkey contract obtained by McDowell in the current boom in steel industry sintering plants. Others include one completed for Jones & Laughlin Steel Corp. at Benson Mines, New York, and two presently under construction for United States Steel Corp.

"The industry's program," believes Patrick V. Gallagher, vice president of McDowell Co., Inc. for its Dwight-Lloyd Division, Cleveland, "is far from complete. Sintering equipment tends to increase the steel industry's iron capacity without additional blast furnaces. Results are that several other major companies are preparing to let contracts. Also, the steadily increasing quantities of iron ore fines available, coupled with the economies of a beneficiated blast furnace feed, are making sintering more and more attractive to the smaller steelmakers."

CARPENTER TAKES OVER NORTHEASTERN STEEL

▲ The Carpenter Steel Co. officially took over the Northeastern Steel Corp., Bridgeport, Conn. on November 19.

The Northeastern concern becomes a wholly owned subsidiary of Carpenter, whose home office and plant are in Reading, Pa. It will be known as Carpenter Steel of New England, Inc.

Final takeover of the local facilities followed the expiration date for appealing the order entered on Oct. 7 by the U. S. District Court in New Haven, confirming the acquisition by Carpenter.

"We have great confidence in the future of our newly acquired Bridgeport subsidiary," Frank R. Palmer, Carpenter president, declared. "We have been trying since 1940 to expand our capacity fast enough to meet the growing demand for our specialty steels.

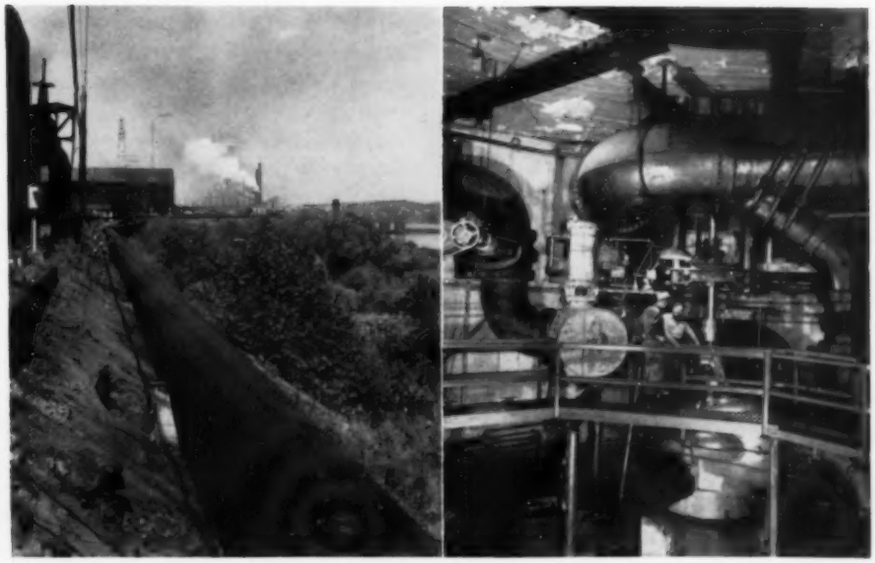
"The acquisition of these additional steelmaking facilities will result in a combined annual production capacity of 170,600 ingot-tons," he said. "This is approximately double our former capacity."

As soon as production facilities are ready, Carpenter of New England will start making electric furnace quality alloy and stainless steels at the local mill, which was rebuilt and modernized in 1955. The old open hearth furnaces will be dismantled to allow space for additional expansion as it becomes necessary.

Carpenter submitted its offer for the acquisition of Northeastern Steel on June 5. After extensive hearings, a plan of reorganization based on the Carpenter offer was approved by the U. S. District Court as well as by Northeastern's creditors and holders of the company's first mortgage bonds and subordinated debentures.

EXPANSION BOOSTS WATER SUPPLY AT ALIQUIPPA

A 42-in. pipeline (left), installed at the Aliquippa Works of Jones & Laughlin Steel Corp. as part of a pump house expansion program by Dravo Corp., extends for ¾ mile through the mill yard, a large part of it underground and terminating 14 ft below the company's bar mill. A 40-ft tunnel was constructed to make the necessary connection with existing water supply lines. Workmen in the central pump house (right) make adjustments to a 40 million gallon per day pump, one of two recently installed. Tied into the existing system at Aliquippa, the addition boosts water supply to 345 million gallons per day. One of the pumps will remain on an emergency stand-by condition.



Keystone integrated aluminum conductor systems feature long life, minimum downtime, low installation costs, increased safety and high current capacity. Surrounding photo shows system being installed.

No winter downtime with Keystone Aluminum Conductor System

For two winters—and going into the third—Niagara Mohawk Power Company, Buffalo, has enjoyed trouble-free service with a Keystone integrated aluminum conductor system. The system replaced one of wire used with Niagara's traveling coal storage towers.

Service conditions are severe here. Ice is a big problem. Sulphuric acid fumes from coal piles cause corrosion. But with aluminum Inverted-V Keystone conductors and enclosures, these problems are solved.

Other advantages of Keystone integrated conductor systems improve operations indoors, too. Low voltage drop—rugged components—no wires to burn down. Steady operation is assured.

For further case history information and data on use of Keystone Aluminum Conductor Systems, call or write *Electric Service Works, Delta-Star Electric Division, H. K. Porter Company, Inc., Philadelphia 32, Penna.*

H. K. PORTER COMPANY, INC.

DELTA-STAR ELECTRIC DIVISION

Carpenter issued 40,000 shares of its own common stock to the Northeastern trustees in exchange for the entire new issue of Northeastern stock under the plan of reorganization. The balance of the purchase price is represented by the reorganized corporation's assumption of $6,000,000 first mortgage bonds.

REM-CRU INSTALLS NEW WALKING BEAM FURNACE

▲ Rem-Cru Titanium has put into production a new continuous walking beam furnace at the Park Works of Crucible Steel Co. of America.

Designed and built by the Loftus Engineering Corp., the furnace is approximately 40 ft long and 14 ft wide.

Two parallel rows of titanium packs are conveyed through the furnace by means of a walking beam mechanism that continuously delivers the heated titanium to the rolling mill.

J&L STEEL PRODUCES PURE COAL CHEMICALS

▲ First production of pure coal chemicals in the steel industry was announced by Jones & Laughlin Steel Corp. A new plant at J&L's Aliquippa, Pa, Works has started production of high grade benzene, toluene and xylene. A light oil containing these components is produced from the coking of coal to make metallurgical coke for the blast furnaces at J&L's three steelmaking plants in Pittsburgh, Aliquippa, and Cleveland.

The purity of these products exceeds the requirements of standard specifications of the chemical and allied industries. Coal chemicals of this higher quality are in demand for making many products, including synthetic fibers, synthetic rubber, insecticides, dyes, drugs, and other chemicals.

The plant has a rated capacity of 55,000 gallons per day of light oil. At a cost of more than $2,000,000, it combines the "Hydrofining" and "Udex" processes which have been adapted to coal chemical purification. Both of these processes are advanced refining methods which not only improve product quality over that possible with the processes formerly used, but increase quanti-

ties recovered as well.

The light oil from the coke ovens contains a high percentage of aromatic hydrocarbons (benzene, toluene, and xylene). Contaminating sulphur compounds and non-aromatic hydrocarbons are removed by the two processes. This purified light oil is then separated into benzene, toluene and xylene by distillation.

Purity of the final products is indicated by the fact that sulphur compounds are reduced to less than one part per million (1 ppm). Benzene has a high solidification temperature and both benzene and toluene contain less than one-tenth of one per cent of saturated hydrocarbons and paraffins.

A major feature of J&L's new refining process is the ability to separate the benzene, toluene, and xylene as high-purity products without making intermediate materials. This is accomplished by automatic control of highly-instrumented distillation equipment.

CALUMET STEEL PLANS EXPANSION PROGRAM

▲ Calumet Steel Division of Borg-Warner Corp. has completed plans for a multimillion dollar expansion and improvement program at its facilities in Chicago Heights, Ill.

The program, largest ever undertaken by the Division, will be divided into two stages, the first of which will increase capacity by at least 40 per cent, improve product quality, broaden the product line, reduce costs, and make possible 24-hour-a-day operation.

Under this phase of the program Calumet will construct a combination rail, axle, and billet heating furnace, a new roll conditioning and machine shop, new fence post finishing shop, expanded merchant bar finishing and reinforcing bar fabrication shops, and additional stands and tables for the present 14-inch rolling mill. In addition, there will be tube mill improvements, relocation and rearrangement of the material yard, and other betterments.

This phase of the program is scheduled to be completed by the end of next year.

The second phase of the program, which contemplates the installation of electric furnaces and additional rolling and finishing facilities, is scheduled for completion by mid-1961. Purpose of this part of the undertaking is to broaden the division's market base and add to the line new billet steel products.

VIENNA FIRM ORDERS WESTINGHOUSE DRIVES

▲ Austria's largest industrial and mining enterprise has ordered over $8,000,000 in electrical equipment from Westinghouse Electric International Co. to power three new steel rolling mills.

The new mills are being added by Alpine Montan, Vienna, in a $56 million modernization and expansion program aimed at doubling its yearly output of finished products to 800,000 tons. A total of 46 main drive motors delivering 37,350 hp will be supplied by Westinghouse for a combination merchant bar-hot strip mill and a four-strand rod mill, both to be located at Donawitz, and an alloy bar mill to be installed at Judenburg.

Alpine Montan is noted as a producer of high-grade alloy steel and as a pioneer in the oxygen converter process in steelmaking. About 85 per cent of the company's alloy steel production is exported, some of it to the United States.

The project is being partially financed through a $20 million credit Alpine Montan received from the Export-Import Bank.

NEW PUMP PRODUCTION LINE NOW OPERATING

▲ The Wilson-Snyder Works of U. S. Steel Corp.'s Oil Well Supply Division began operations Nov. 10 on its new modern centrifugal pump production line at Braddock, Pa.

Equipment in this plant is designed to permit the machining, assembling, testing and shipping of centrifugal pumps in one continuous operation, thus assuring closer tolerances and specifications of these pumps.

Housed in a new building 140 ft long, the new facilities include recording and metering equipment, balancing machines and special calibrated motors to test volume and water pressure. Water for testing four pumps simultaneously is stored in a 40,000-gallon reservoir, 15 ft deep with double concrete walls.

BASIC SPECIALTIES BY GREFCO for the Steel Industry

GREFCO PCO (plastic chrome ore) is an air-setting material available in several mixes of varying workability. After application by ramming it develops high strength and hardness upon air-drying. After firing it develops a dense hard surface which is unusually resistant to mechanical abrasion.

GREFCO PCO's chemical composition provides excellent resistance to attack by fluxes and slags such as roll scale, open hearth slag, and coal ash. Low porosity makes it highly resistant to penetration by molten metals or slags.

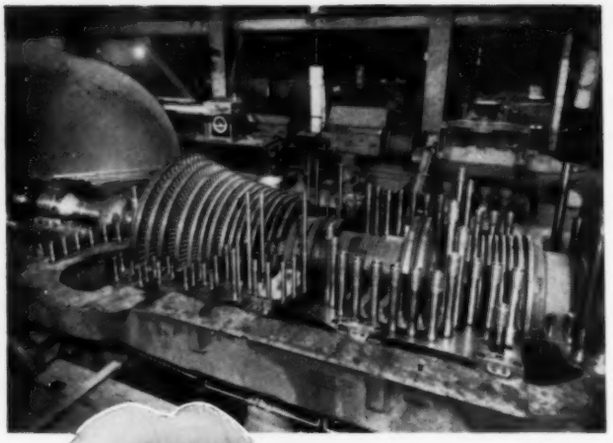
MAGNEHARTH is a ramming mixture made from dead-burned magnesite grains of high magnesia content, plus chemical bonding agents. When used in the bottoms of open-hearth and electric steel furnaces, MAGNEHARTH provides a highly refractory, stable, and long-lasting hearth. It can also be used with excellent results for resurfacing old bottoms, for forming tap holes, and for hot and cold patching in steel furnaces.

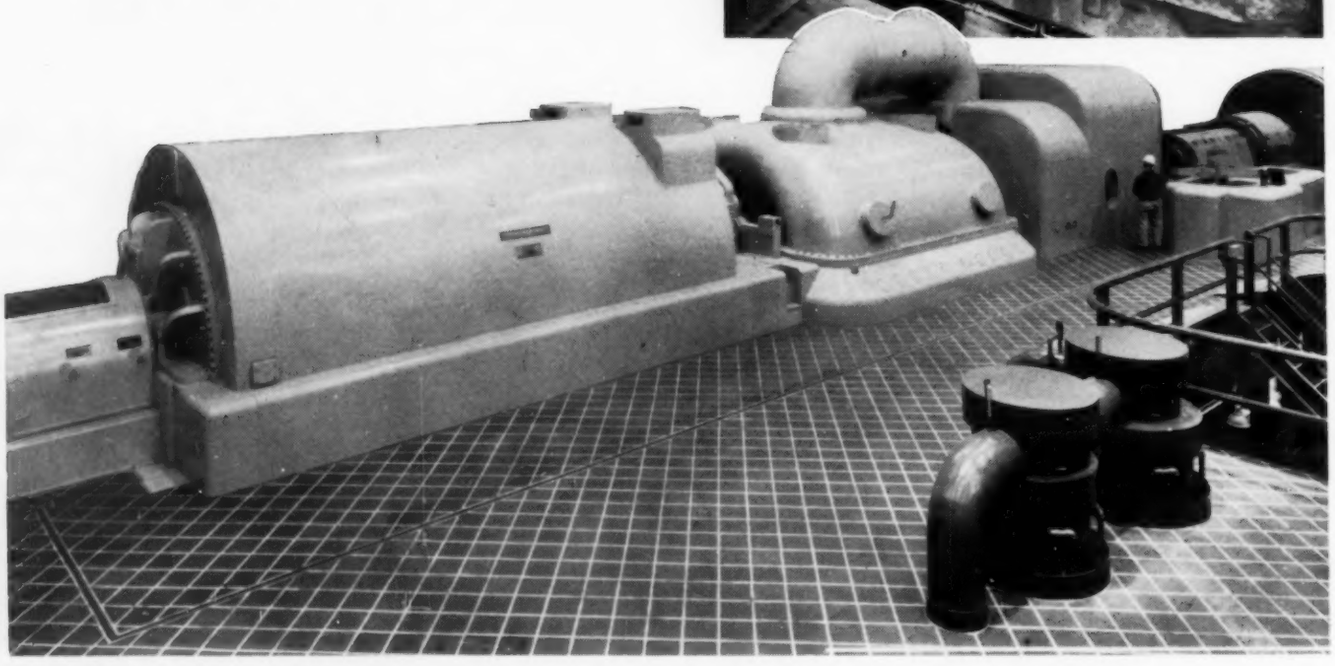
Consultation with a Grefco representative is recommended to be assured of the proper material for your service and conditions. He can furnish you with detailed instructions on the proper installation procedure, too.

GENERAL REFRACTORIES CO.
Philadelphia 2, Pa.

GENERAL REFRACTORIES

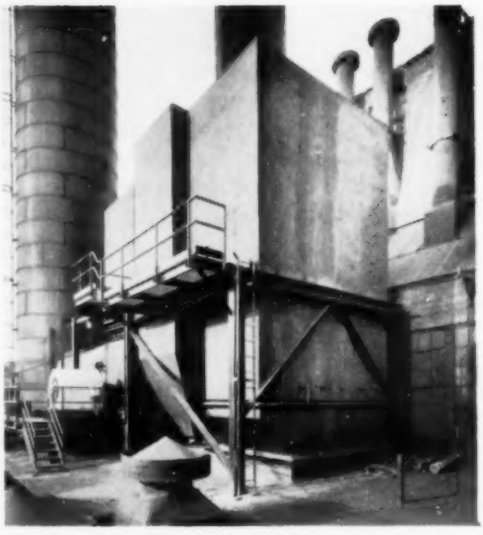
Duquesne Light Company
Installation at
Frank R. Phillips Station
and Colfax Station





Installation of Mechanical Dust Collector and associated equipment for 3 boilers at the Colfax Station.

Complete installation including all services of one Westinghouse 125,000 KW, 2-cylinder Tandem Compound, Hydrogen Cooled Turbine Generator with required appurtenances at the Frank R. Phillips Station.



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ACQUIRES OWNERSHIP OF REM-CRU TITANIUM

▲ Crucible Steel Co. of America announced that, subject to Securities and Exchange Commission approval, it has acquired 100 per cent ownership of Rem-Cru Titanium, Inc. by an exchange of 150,000 shares of Crucible common stock for the entire half interest owned by Remington Arms Co.

This acquisition will give Crucible facilities for production of titanium and vacuum arc-melted steel products.

Rem-Cru Titanium, Inc. was organized in 1950 as a joint venture of Remington Arms Company and Crucible. In plant facilities adjacent to Crucible's works at Midland, Pa., it has produced titanium ingots, slabs and billets from purchased titanium sponge for conversion into sheet, bars, wire and other mill products, chiefly in the Crucible plants.

SET CONSTRUCTION DATE FOR TRAFFORD PLANT

▲ Construction of the new Westinghouse Electric Corp.'s multimillion-dollar power circuit breaker plant in Trafford, Pa., will begin in early 1958.

J. W. Stirling, manager of the power circuit breaker department in East Pittsburgh, Pa., will head the new plant when it is completed. Contracts for the structure have been awarded to Kaiser Engineers.

The new plant will be a one-story structure with a total of 241,000 sq ft of manufacturing space. The building will be 550 ft long, 420 ft wide and will be comprised of seven bays—one of which will be 60 ft high.

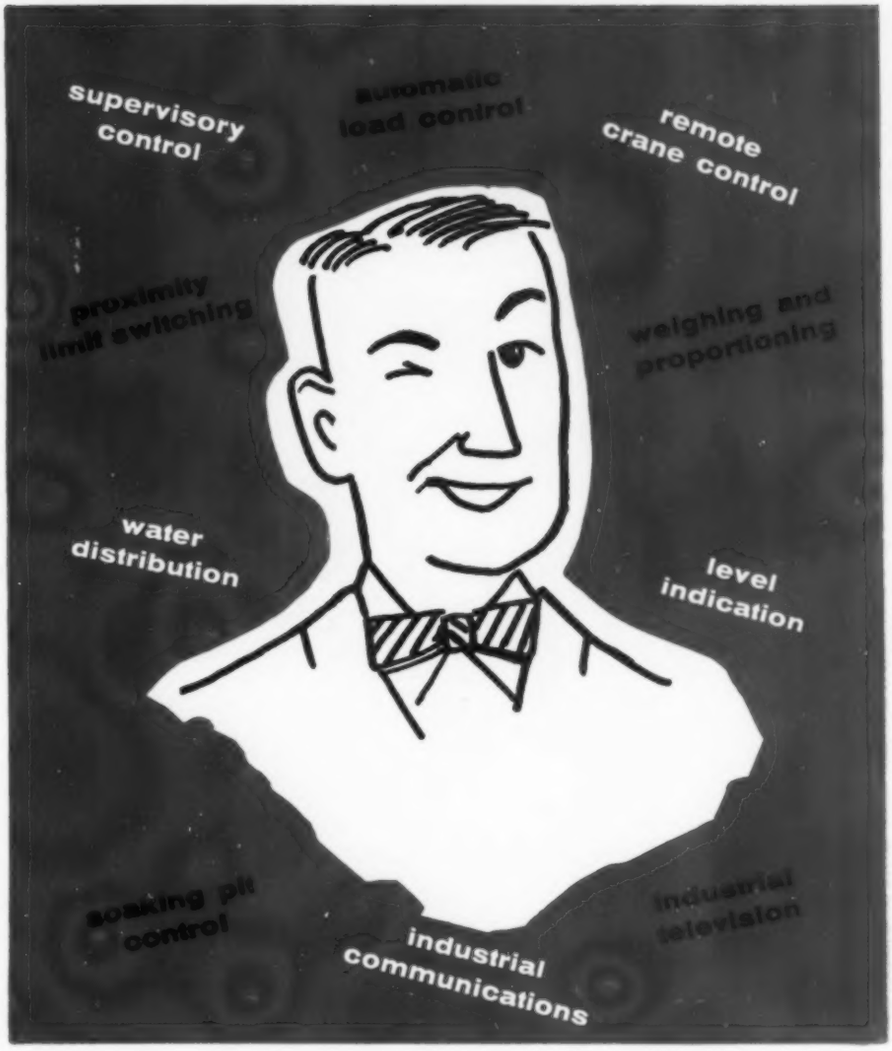
The plant is scheduled to be in full operation by 1959.

Mr. Stirling said that expansion of the power circuit breaker department in East Pittsburgh was prohibited by topographical conditions.

"Our backlog of orders and forecasts for the future of power circuit breaker apparatus confronted us with a serious problem. Our only solution, after careful examination and consideration, was to move a major portion of our switchgear activity out of East Pittsburgh."

The space currently being occupied by this department at East

A Femco Sales Engineer is a good man to know!



With standard components, Femco provides simple, low-cost solutions of control and indication problems.

Femco engineers have developed a line of standard components, with which many different systems can be designed to provide *automatic remote control, indication, monitoring, inter-communication* or *televised observation.*

The way to find out how you can profit with a Femco system, is to get acquainted with your nearest Femco sales engineer. Phone or write for an appointment.

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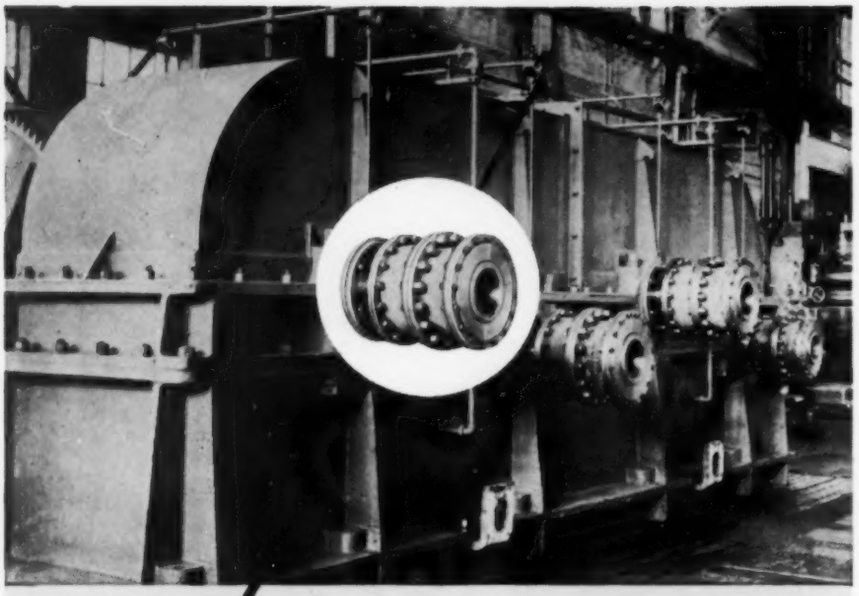
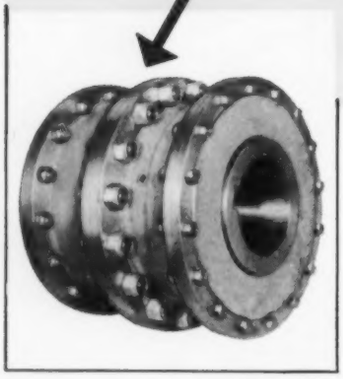
MAKERS OF THE FAMOUS FEMCO TROLLEYPHONE



Waldron heavy duty mill type couplings on rod mill

WALDRON

flexible couplings...



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same 3 reasons

1 STRENGTH — Hubs and cover sleeves for sizes 1¼ A through 7A are machined from tough steel forgings. Hubs are keyed to the shafts. The two one-piece cover sleeves function as a single, rigid unit serving as a floating connecting link between the hubs. High strength of forgings makes possible a very compact coupling with low rotating inertia.

2 RELIABILITY — There are no flexible parts to bend or break and the coupling is dust, moisture, and oil tight. Patented Walflex seal is at the lowest possible diameter where centrifugal force is least. Clearance between teeth in hubs and sleeve is engineered so that an oil wedge always separates them, taking the wear.

3 SERVICE — Plenty of rough bore couplings, already assembled—on the shelf for *immediate* delivery. Finish bored standard couplings shipped to meet customers' schedules. We are geared up to give you realistic delivery on *any* type of couplings.

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Pittsburgh will be fully used by expanding other switchgear departments.

CIT OFFERS COURSES FOR GRADUATE STUDY

▲Carnegie Institute of Technology, College of Engineering and Science, Pittsburgh, Pa., announces availability of teaching assistantships, graduate fellowships, and research assistantships for the academic year 1958–1959, offering opportunities for advanced study and research leading to the degrees of Master of Science and Doctor of Philosophy in chemical engineering, chemistry, civil engineering, electrical engineering, mathematics, mechanical engineering, metallurgical engineering, nuclear science (degree of master of science only), physics. Third-time and half-time teaching assistantships are available to graduate students in all departments of the college.

Third-time teaching assistantships carry a stipend of $1200 plus tuition per academic year for the first year and $1300 plus tuition for the second year.

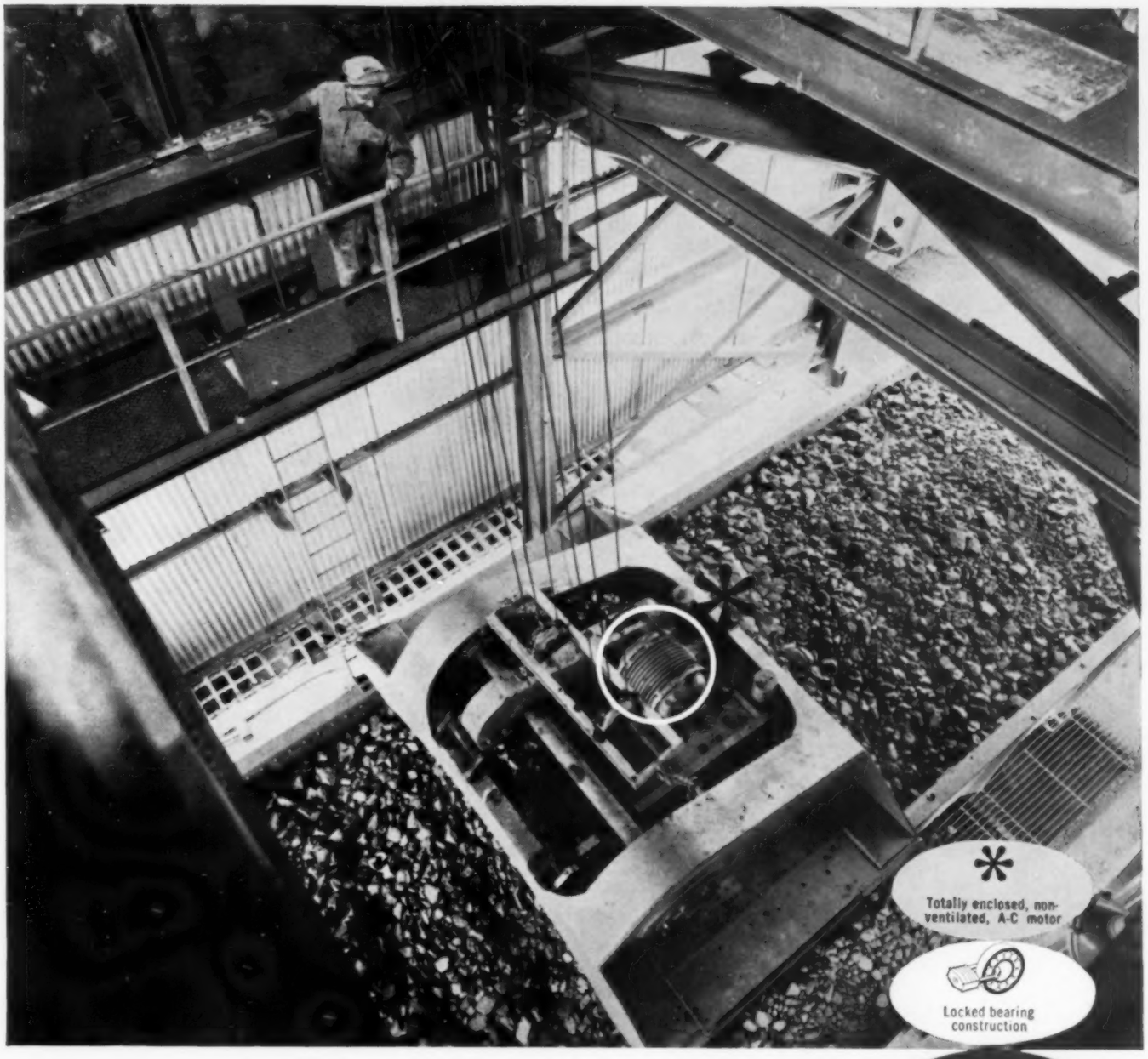
For half-time teaching assistantships the stipend for the first year is $1500 plus tuition per academic year, the second year $1600 plus tuition for the second year.

Research assistantships, under the supervision of a member of the staff, are available to graduate students in most departments of the college. Stipends are comparable to teaching assistantships; third-time research assistants may carry a normal load of graduate study, half-time assistants up to five-sixths of a normal load of graduate study.

There are some full-time research assistantships available to graduate students for two and one-half months in the summer.

Most departments of the college offer graduate fellowships carrying grants ranging from $1200 to $2500 in addition to tuition awarded to outstanding graduate students, permitting full time to advanced study and research.

Bulletin of Graduate Study in Engineering and Science will be sent on request. Applications from qualified students who wish to begin or return to graduate study in the Fall of 1958 will be considered. Applications for admission to graduate study and for assistantships or fellowships, together with transcripts



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Ask a Louis Allis sales engineer to survey your materials-handling motor and drive needs. He's a motor expert and will make sound recommendations, without obligation, of course.

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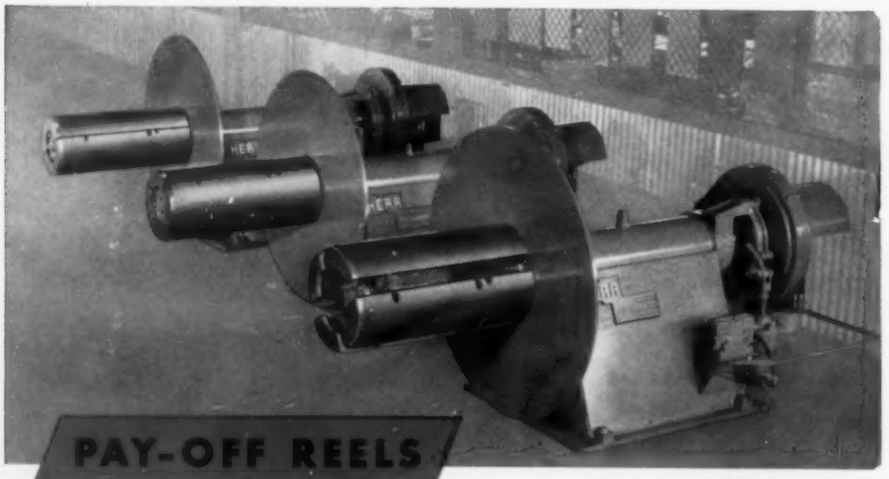
For fast, efficient loading of pay-off reels and unloading of coiling reels. Sizes to handle coils of any diameter, width or weight. Hydraulic lift, electric traverse. No pits. Can be fitted with coil ejector, up-ender and other accessories if desired. Furnished complete ready for use.



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of record and other supporting evidence, should be submitted as early as possible, preferably not later than February 1, 1958. Address all inquiries to: Dean of Graduate Studies, Carnegie Institute of Technology, Pittsburgh 13, Pa.

INSTALLS PRECIPITATOR AT YOUNGSTOWN PLANT

▲A crew from the Koppers Co., Inc., has started erection, at Youngstown, Ohio, of the 50th Koppers electrostatic precipitator unit purchased by the United States Steel Corp.

Designed and fabricated by Koppers Metal Products Division, in Baltimore, the precipitator will clean gas from the No. 4 blast furnace at U. S. Steel's Youngstown plant. Erection will require about two months.

The new unit is a single-chamber, horizontal-flow, irrigated type precipitator, designed for an efficiency of 90 per cent when treating 111,000 cu ft of saturated blast furnace gas per minute at a temperature of 115 F and with a dust loading of .122 grains per cu. ft It will be energized by a vacuum tube power unit controlled by a Koppers automatic power regulator.

The Youngstown installation will be the eighteenth Koppers precipitator unit to go into service on blast furnaces of the U. S. Steel Corp. In addition, Koppers has 18 precipitator units on U. S. Steel open hearth furnaces.

Thirteen other Koppers units are in use or on order by U. S. Steel. eight for iron ore sintering plants and five for de-tarring operations at various U. S Steel plants.

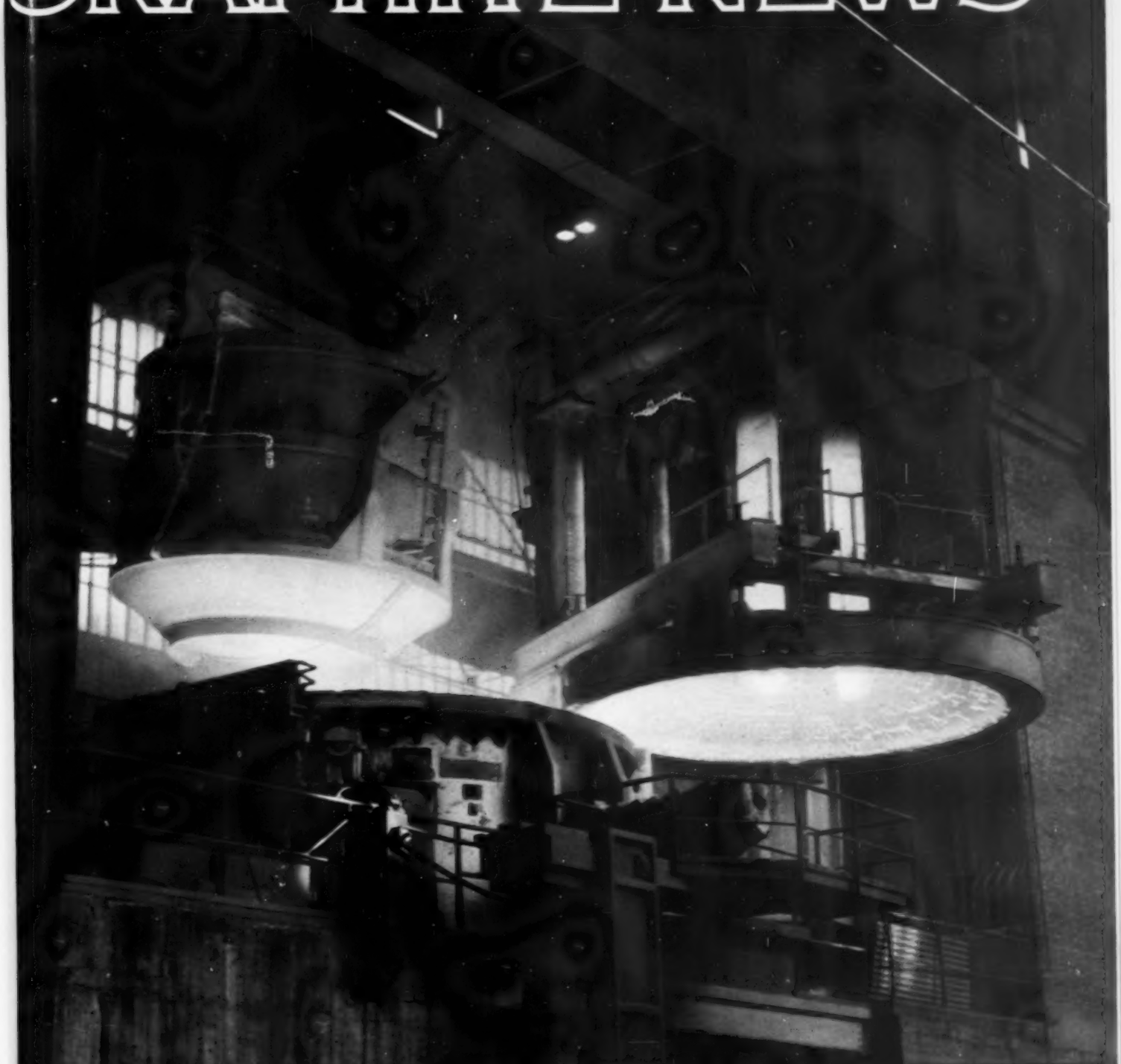
U. S. Steel also has awarded to the Koppers Metal Products Division a contract for eight more blast furnace precipitators to be installed early next year.

Meetings

▲ The 1958 Plant Maintenance & Engineering Conference will be held at Chicago, Ill., during the first three days of the Plant Maintenance & Engineering Show, which is scheduled for the International Amphitheatre, January 27-30. Conference sessions will be held both at the Amphitheatre and the Palmer House.

NATIONAL CARBON COMPANY'S

CARBON AND GRAPHITE NEWS



IRON ORE REDUCTION AND THE ARC FURNACE*

By: Harry W. McQuaid

IRON ORE REDUCTION AN

Over five hundred years of development brought the modern blast furnace to its present size and present quality of product. Today, the blast furnace has reached its zenith in the fully integrated steel plant. Teamed with ore handling equipment and the coke oven, the blast furnace supplies steel melting furnaces with a charge of hot, fluid, molten iron.

THE ARC FURNACE*

BY **HARRY W. McQUAID**

Consulting Metallurgical Engineer

* Based on a paper delivered by H. W. McQuaid at the 1957 Annual Convention—Association of Iron and Steel Engineers.

Blast Furnace Limitations

Burning coke with preheated air for combustion, the blast furnace converts commercial iron oxide (ore) and an alkaline reagent (limestone) to a molten state. The reduction of iron ore by carbon monoxide which is formed by partial combustion of coke, is a relatively slow process. In addition, the process is badly handicapped by the need to melt high percentages of flux plus the melting of ore and nonmetallics under high reducing conditions.

One principal improvement which might be made in blast furnace hot metal or pig iron, would be to drop the carbon (not below 2%) and eliminate silicon and sulphur. Such a charge would be ideal for both the open hearth and the electric furnace, especially for heats which must pass cleanliness tests and be employed as an alloy steel base. Some will note that unless low sulphur fuels are used on the open hearth and in the scrap, the low sulphur, low silicon hot metal or pig is probably a wasted refinement.

However, it is my experience that a low sulphur and low silicon hot metal or pig addition, when associated with a good carbon boil, is helpful in obtaining good looking billet etches, particularly in heats on the hot side and not too fully deoxidized.

Due to the increasing height and diameter of the modern blast furnace, the need arises for an improvement in coke quality and uniformity, ore preparation, and burden uniformity. Because of this, the future development of the blast furnace seems to be becoming more uncertain every day. As a matter of fact, it has apparently reached the stage of its existence where every possible commercial step will be taken to replace it.

Objectives Of Direct Reduction

The first objective of direct reduction is to obtain relatively low cost equipment for producing commercial grades of iron to compete with cold pig iron or good grade scrap. And, to produce iron that can be somewhat independent of coke—at least high grade, special quality coke. Many processes for the direct reduction of iron ore to replace scrap or blast furnace pig iron have been proposed in the past forty years. Though many of the attempts were unsuccessful, they have been of value in indicating what should be avoided for a successful direct reduction process.

In recent years, the advances made in ore concentration and the removal of gangue material prior to reduction have greatly improved the chances of direct reduction success. For example: the preparation of finely divided concentrated ore has improved the reaction rate and the thoroughness of reduction. Also, final mixing of the highly concentrated, finely divided form with a reagent selected for oxygen removal, has been developed to assure complete reduction.

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Electric Furnace Melt Shops

Every hot metal and pig iron user in this country and Europe is patiently waiting for the time when iron ore can be directly reduced (in low cost equipment) to either liquid or solid iron. Actually the first to be attracted by such direct reduction equipment should be the electric furnace melt shop. The use of the direct reduction process to stabilize the price of scrap will be of the greatest interest to every electric furnace high tonnage operator in the country. While liquid iron would be of advantage in replacing scrap in the electric furnace, any form of solid iron would also be desirable. The electric furnace can use iron in any form (hot or cold) as its basic charge material.

It will be especially desirable to electric furnace melt shops if small yet efficient direct iron oxide reduction plants can be built at a relatively small investment cost and operated in parts of the country where high grade coking coal is difficult to obtain.

Hydrogen As A Reducing Agent

Hydrogen may play an increasingly important part in the reduction of iron ore. It is entirely possible as the development in the field takes place, hydrogen requirement on a commercial basis will be below 25,000 cubic feet per ton and might approach 20,000. It is easy to arrive at an estimate of the direct reduction costs for the hydrogen reduced product, which now finds its initial tonnage application in the special low sulphur electric furnace charge. Its principal competition would be extra high grade scrap. A study of costs available indicates the production of a high carbon, low sulphur charge such as "H-Iron" should be carefully considered by every electric furnace melting plant producing low sulphur special steel. This is one means of insuring some stability in the cost of the charge which goes into the melting furnaces. It is appealing in areas of high scrap costs and in areas of low natural gas costs. This indicates a field in Pittsburgh (high scrap costs) and Texas (low fuel costs).

Studies have shown that not only "H-Iron" but other hydrogen reduction operations can be reduced to a practice which will produce a melting furnace charge for replacing #1 and #2 heavy melting scrap in almost any furnace. On this basis alone, hydrogen reduced iron ore has a reasonably bright future as long as steel scrap keeps its sensitive relation to supply and demand. It should have the best wishes and interest of every electric melting furnace operator throughout the country.

Carbon As A Reducing Agent

In considering the direct reduction of iron ore, let us remember that if the product which results from such a process is above 95% in iron content, low in carbon and silicon, we wind up with a high iron product with a high melting point. This would be primarily competitive with scrap and not with hot metal or pig iron. In fact, directly reduced iron ore in the form of a very low carbon, low silicon iron of high purity will not fit at all in the open hearth economy. It would fit much better into the electric melting picture where its economic position would be directly compared with available scrap. Both electric furnaces and open hearths would benefit if a relatively high carbon, low silicon iron were available preferably as hot metal or as a cold pig charge.

If another means of reducing iron oxide (ore) for the open hearth or Bessemer is developed, it will be economically necessary to use carbon or carbon monoxide as the basic reducing agent. This is necessary to produce iron in the liquid form and to control the silicon to best suit the melting furnace requirement. The logical approach to such an end would be to melt the highly concentrated iron ore under the best fuel and oxidation conditions of oxygen enriched blast, high temperature combustion. And, to treat the largest possible surface of molten, superheated ore with incandescent carbon and superheated flux. This appears to be a problem for the best combustion engineers and furnace builders. The reduction of iron ore (oxide) by treating it in the molten state with carbon is fast becoming an important means of obtaining iron from ore. It promises someday to become a strong rival of the blast furnace in areas where high grade coke is difficult to obtain.

Hence, no matter what method of iron ore reduction we study—carbon, carbon monoxide or hydrogen, three principal factors in our efforts to improve the process are important: First, the intimacy of the mixture; Second, the continual removal of the reaction products; Third, the accurate control of the temperature.

Look Ahead— Look Electric

Gives greatest flexibility—
Makes any steel—any time—from stainless to plain carbon. Handles cold scrap, metallics, hot metal. Starts, stops quickly—gives faster melts.

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Savings of 25% and more vs. open hearths producing same tonnage.

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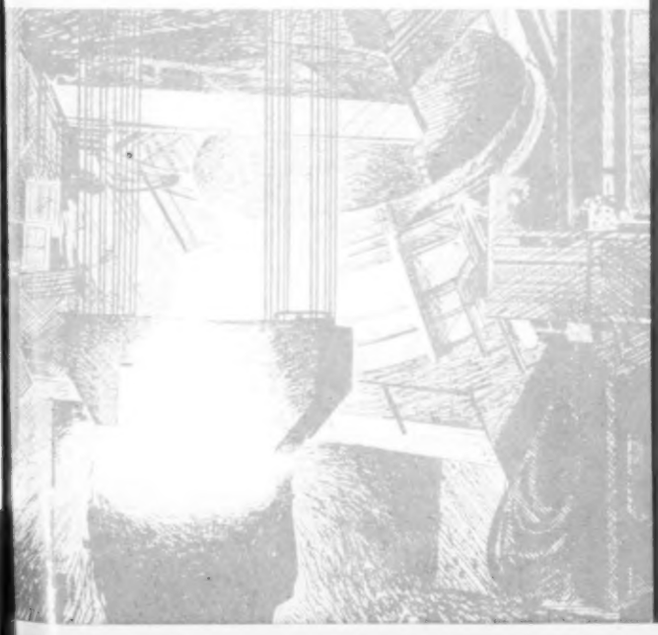
No combustion products to contaminate melt.



Submerged Arc Ore Reduction

Under certain conditions where transportation charges, power and other costs are favorable (as they are in many locations), the direct reduction of iron ore by smelting in the submerged arc furnace is more economical than the blast furnace. This is true if we have to engineer and build a blast furnace at present day costs. Here, the high cost of building a new blast furnace involves carrying (fixed) charges which make the submerged arc furnace look especially attractive.

The deoxidation of molten and superheated iron ore with carbon in an electric arc furnace occurs with tremendous rapidity if the carbon-iron ore mixture is intimate and a violent reaction can be permitted. The rate of reaction can be regulated to suit the operator by controlling the temperature and the rate of carbon feed into the really active bath. The problem becomes one of two distinct phases: First, to produce highly fluid, concentrated iron ore. Second, to control closely the reaction of this iron ore concentrate with intimately mixed, finely divided carbon. So far the most successful practice of the ore reduction method has been in Norway, Sweden, Italy and other parts of Europe as well as South America.

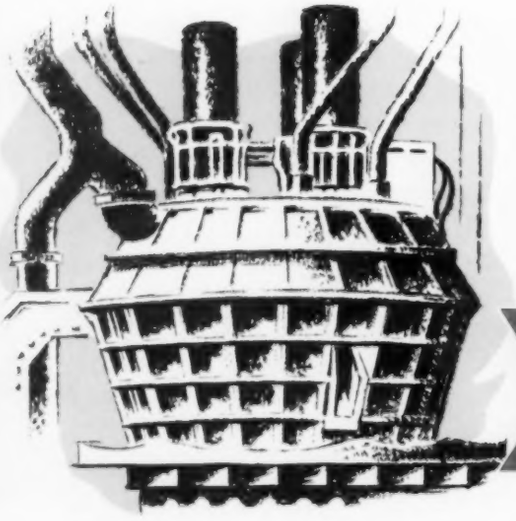
Typical applications in Europe employ the modern electric arc furnace using carbon electrodes which melt and superheat the ore in contact with crushed low grade anthracite. The problem of melting a crushed iron ore and coal mixture in a modern arc furnace is not difficult so long as the ore is molten and the temperature is high enough. The carbon will react rapidly with the oxygen in the fluid ore and reduction is only a matter of minutes. The submerged arc electric furnace is accepted as probably the best means of developing direct reduction of molten iron ore with carbon.

Assuming that a mixture of highly liquid iron ore and carbon is made available, it should be fairly simple to eliminate the oxygen, thereby assuring a liquid charge metal for the open hearth or electric steel furnace. For this reason, the production of hot metal or pig iron from ore might soon become common throughout non-integrated, properly located foundries and steel plants.

Over ten years ago, the first attempts in this field indicated as low as 1300 KW hours per net ton of iron produced when highly concentrated magnetite ore was reduced with carbon in an electric furnace. Now, I am told 1100 KW hours will be closer to the real power requirement per net ton of iron produced in this country. This makes production of electric furnace hot metal or pig iron a very important economic development in the steel industry.

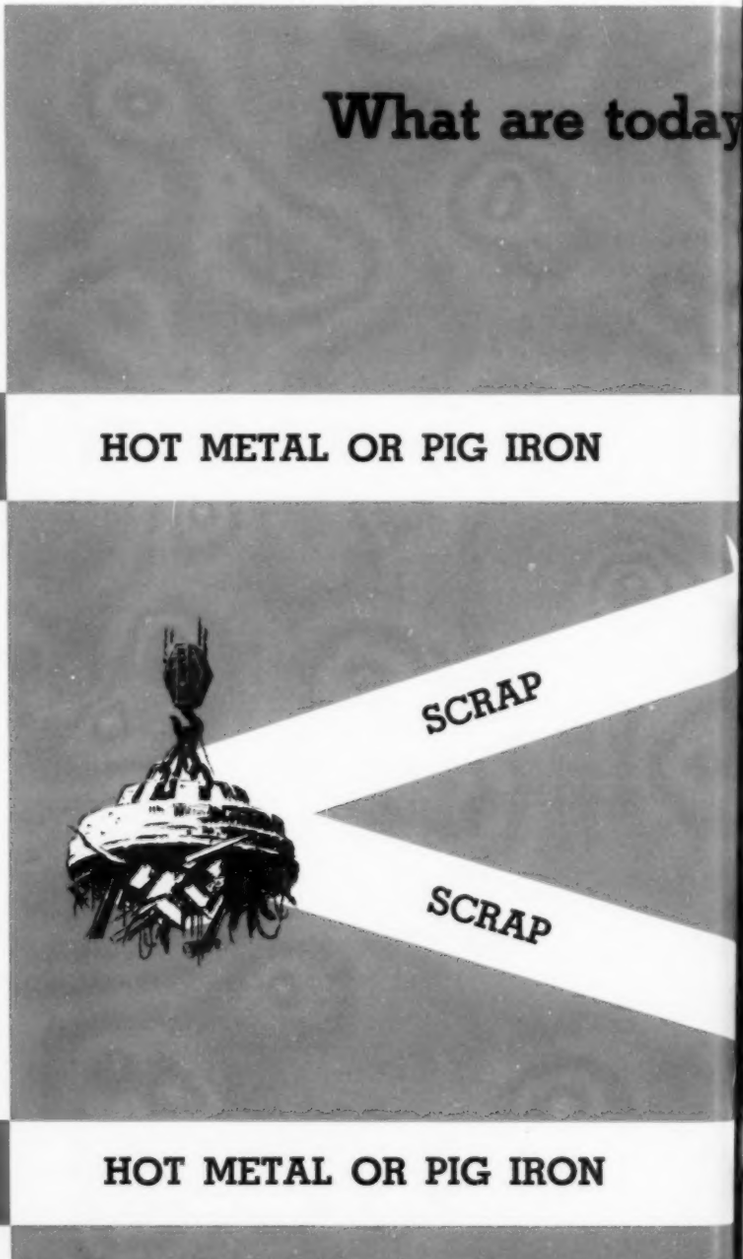
A leading electric furnace steel producer in combination with a large nonferrous metal producer, has now reduced to practice an iron oxide reduction process. This process provides a melting stock fo use in steel mill furnaces supplying any desired grad of steel.

It is early to express any opinion on the actua merits of this direct form of ore reduction, but al considerations (including the experience abroad indicate it is in good hands. The publicity which i expected shortly will, I am certain, show that a nev tonnage method of reducing iron oxide to metalli iron with carbon has been developed. It will rapidl be taken over by those electric furnace operators t whom it is especially suited.



SUBMERGED ARC FURNACE
AND ACCESSORY EQUIPMENT

BLAST FURNACE AND
ACCESSORY EQUIPMENT

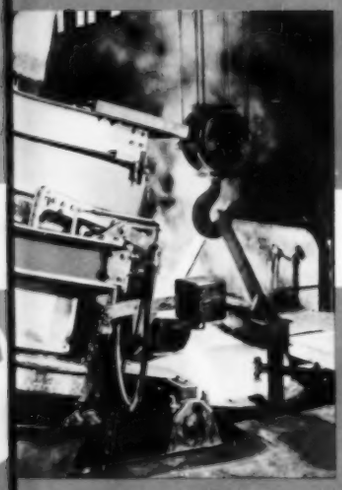


Those interested in this subject should read the article "Electric Furnace Pig Iron" by Dr. E. C. Wright of the University of Alabama, published in the July 1957 Carbon and Graphite News. Also of interest is the chapter on Electric Pig-Iron Smelting by A. G. E. Robiette in his book entitled "Electric Melting and Smelting Practice". These sources offer basic information on the subject of ore reduction by the electric melting furnace.

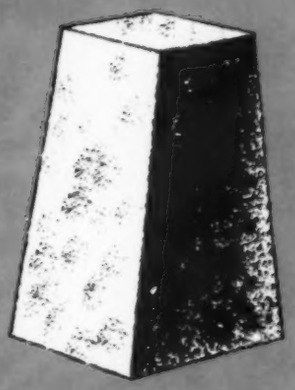
Arc Furnaces In The Integrated Plant

Because of the high investment cost reached in the installation of high tonnage modern open hearth furnaces and accessory equipment, today's thinking has favored large electric arc furnaces. This is particularly true where the present fully integrated open hearth battery is at the full limit of existing hot metal production equipment. Here the addition of one or two large high powered electric arc furnaces can average more than twenty-five tons per hour of semi-killed merchant bar ingots from available scrap. It is interesting when we examine the investment per annual ton, and in this case, the open hearth looks anything but attractive. In some fully integrated

mparative costs per annual ton of steel production?



lectric Furnace



CAPITAL INVESTMENT PER ANNUAL TON OF PRODUCTION

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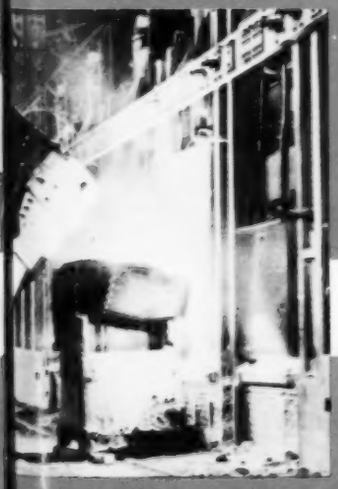
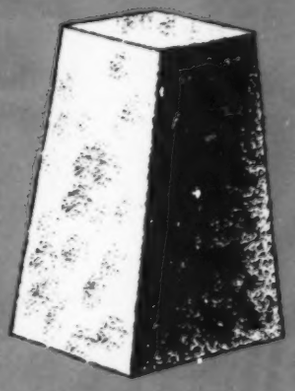
In some fully integrated plants, the present investment of the blast furnace and open hearth combination will cause steel plant executives to give thought to the submerged arc electric for smelting and electric furnaces for refining.



n Hearth Furnace



CAPITAL INVESTMENT PER ANNUAL TON OF PRODUCTION

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plants, the present investment of the blast furnace and open hearth combination will cause steel plant executives to give thought to the submerged arc electric for smelting and electric furnaces for refining. This is evident since the apparent discovery that savings in power will pay for almost any degree of ore concentration attempted.

Conclusion

It seems apparent that several approaches to the direct reduction of iron oxide as a steel melting furnace charge are not far away. As in all important developments, once the industry-wide conditions indicate the new iron product to be economically desirable, it will be developed. The time is not far away when even the relatively small, more distant steel producer will become well integrated by installing a low cost iron ore reduction unit in one corner of the plant. It will provide him with the most economical charge for his melting furnace and the battle will be on between the scrap supplier and the ore salesman. The larger tonnage steel plant using hot metal or cold pig iron will find it wise to investigate the new iron ore melting practice combined with its reduction by carbon to a high carbon, low silicon, low sulphur hot metal.

Whatever develops, it is apparent that the reduction of iron ore to produce either a molten product similar to blast furnace hot metal, or a solid product similar to low carbon heavy melt steel scrap, has now reached the stage where it is being reduced to practice. It will require many months to determine what method or methods will be adopted by the industry. But, when the development is finally adopted throughout the steel industry, we will no doubt wonder why it took so long.

It is interesting to speculate on the heartbreaking rejections met by some men in trying to introduce an outstanding new development to an industry. Especially has this been true in the past with the steel industry where the direct reduction of iron ore was easy to postpone for another year. But today, continually increasing customers' pressure for improved quality in every product and the increasing evidence of better quality, cost and delivery in your competitors' product, has resulted in the highest possible pressure for development of new and better production equipment. Because of the high investment cost of blast furnace open hearth combinations, present equipment will be kept in operation just as long as it is commercially possible. This makes it difficult for the engineer to answer the sales department's request for increased capacity. The electric arc furnace will try to meet this demand.

The answer must be a development in low cost iron ore reduction practice to provide the steel melting furnace and foundry cupola with a material which will reduce in cost, and stabilize the price of its main charge. It is evident that such a development is now in the making and all that is needed for success is an industry wide concentration on the problem and a pressing demand for results.

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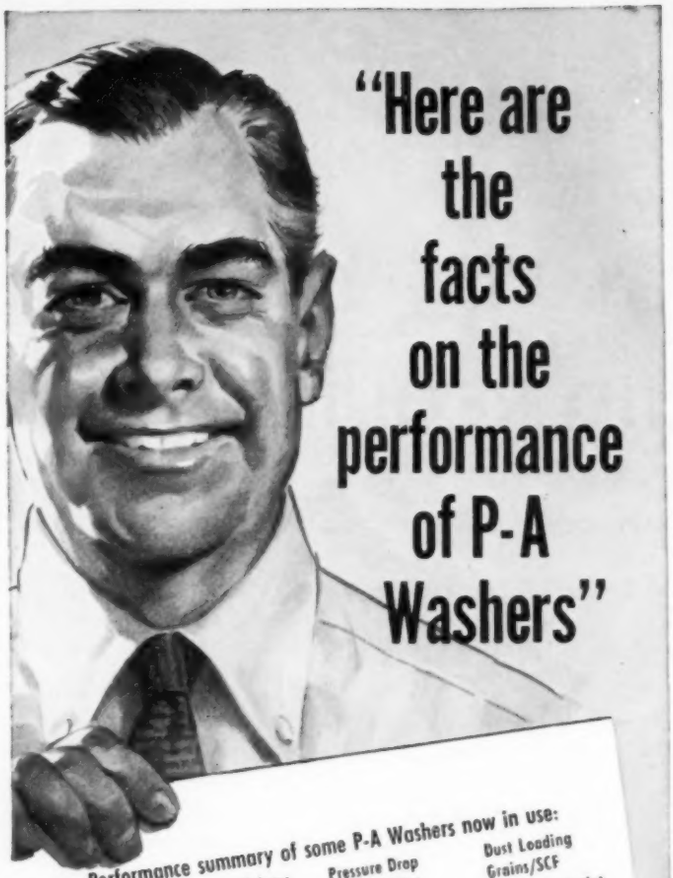

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Performance summary of some P-A Washers now in use:

Installation	Years Operated	Volume SCFM	Pressure Drop Inches Water	Dust Loading Grains/SCF Inlet	Outlet
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C	3	85,000	30-40	2-3	.01-.03
D	3	45,000	30	2	.02-.03
E	½	75,000	50	—	.02
F*	½	26,000	12	5	.10
G*	½	26,000	12	5	.10
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*Two units in parallel on one furnace. Lower efficiency due to lower available top pressure

These actual performance figures reflect the highly efficient operation of the Pease-Anthony washer. This venturi scrubber puts your full top pressure to work cleaning the gas. No secondary cleaner required for most installations. Present users report no maintenance problems. If you have a blast furnace scheduled for construction or rebuilding, plan now for P-A Venturi installation. Capacities up to 150,000 SCFM. Write for bulletin M-103.

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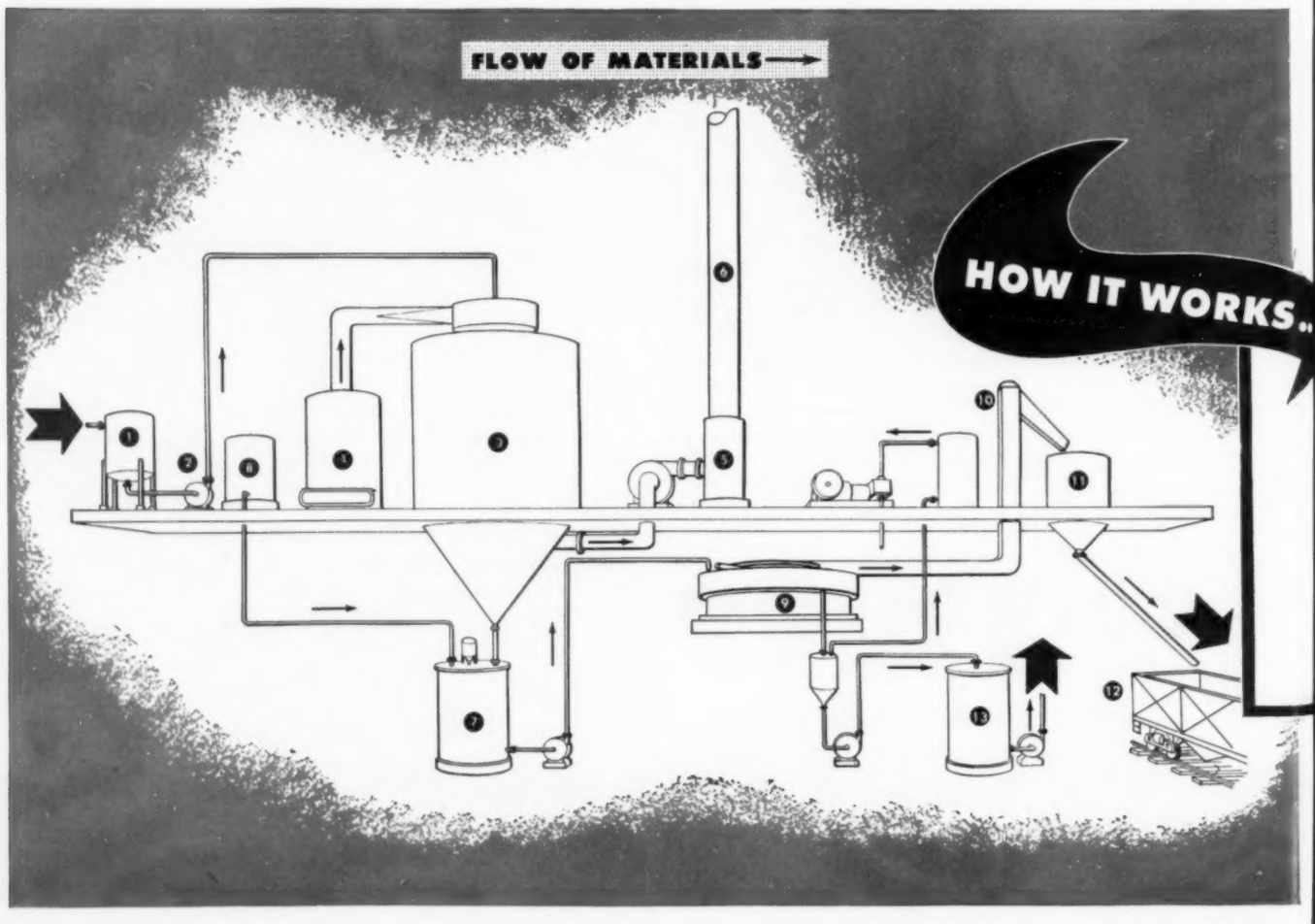
New continuous process, available from Koppers, of pickling acid used . . . and eliminates waste

FOR OVER A QUARTER OF A CENTURY, wherever a pickling line has been in operation, disposal of spent liquor has been a major headache. But now a new continuous regeneration process—the Koppers Inland-Zahn process— goes a long way toward solving this problem. This system is simple, it is economical, and *it has been proved in actual plant-scale commercial operation in Europe.*

With this process, the only make-up acid needed is the amount consumed in the pickling reaction plus normal losses. *All* available free acid in the used liquor is recovered (up to 50% of the original charge). Labor costs are low—just one man can operate the entire regeneration plant. As a result of these savings, operating costs are substantially below those of any presently available disposal method.



pickling line

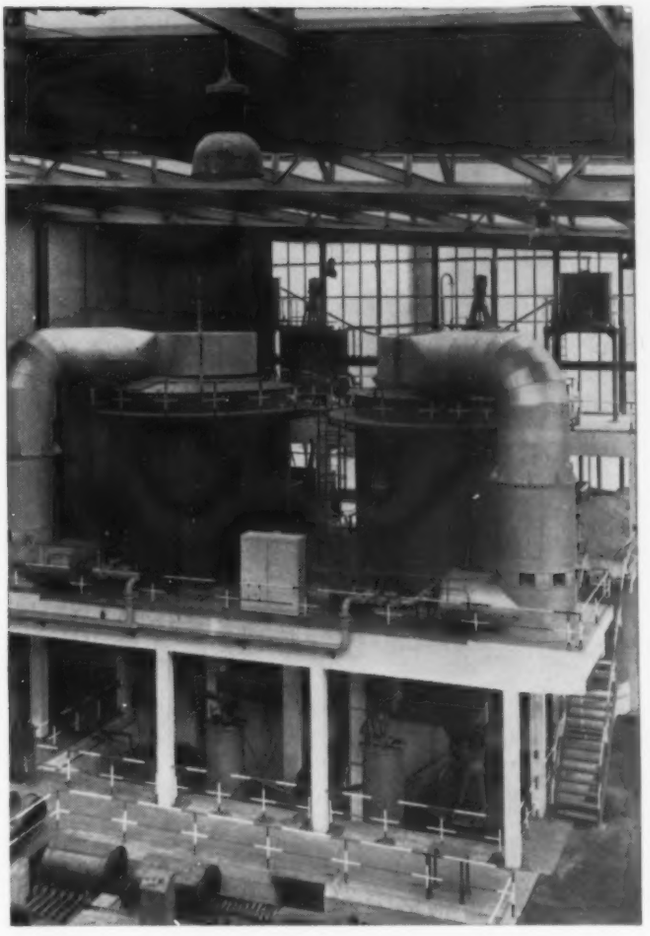
IN HALF!

regenerates up to half liquor disposal problem

PROVED COMMERCIALLY—This process, developed by Inland Steel Company and adapted commercially by Zahn & Co. of West Germany, is now being used successfully in three European steel plants. The benefits achieved include *extremely low maintenance* . . . and more uniform and *higher* acid concentrations in the baths. The latter advantage permits faster steel processing.

NEUTRALIZING PLANTS – The new regeneration process is especially applicable to plants handling 10,000 gallons of effluent, or more, a day. The Chemical Department of Koppers Engineering and Construction Division also designs and builds lime neutralization systems for both large and small pickling operations. Send the coupon for complete information about these and other Koppers Chemical Engineering Services.

Spent pickle liquor (1) is pumped (2) to spray head in an evaporating chamber (3). Here, hot air and flue gases from a combustion chamber (4) concentrate the liquor and cause the ferrous sulfate monohydrate to crystallize out of solution. Vapor laden air is discharged to atmosphere through a mist eliminator and stack (5 and 6). The slurry is dropped into a crystallizing tank (7) where fresh sulfuric acid is added from a metering tank (8). This causes more monohydrate to drop out. The slurry is then separated in a vacuum filter (9) and washed. Salt is conveyed to bins or hopper cars for sale or disposal (10, 11, 12). Mother liquor, containing about 35% acid and 1-2% iron, is pumped to a holding tank (13), ready for dilution and return to the pickling tanks. No reheating is required.



HEART OF THE SYSTEM—This spray dryer concentrates spent liquor to slurry of ferrous sulfate monohydrate crystals suspended in acid. The plant shown here, in Germany, has operated since June, 1954, processing 48,000 gallons per day of waste liquor.

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Koppers Company, Inc.
Engineering and Construction Division
1451 Koppers Building
Pittsburgh 19, Pennsylvania

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- ☐ **Lime neutralization of spent pickle liquor by Koppers.**
- ☐ **"3 Keys to Selecting Your Industrial Contractor," a brochure describing the variety of Koppers construction services and giving reasons why Koppers should build your next chemical plant.**

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Extra-safe, unbreakable, non-carbonizing insulating bushings have fiber glass base with alkyd resin binder for greater shock resistance. Design gives ample creepage distances, superior anti-tracking qualities . . . prevents build-up of dust on bushing.

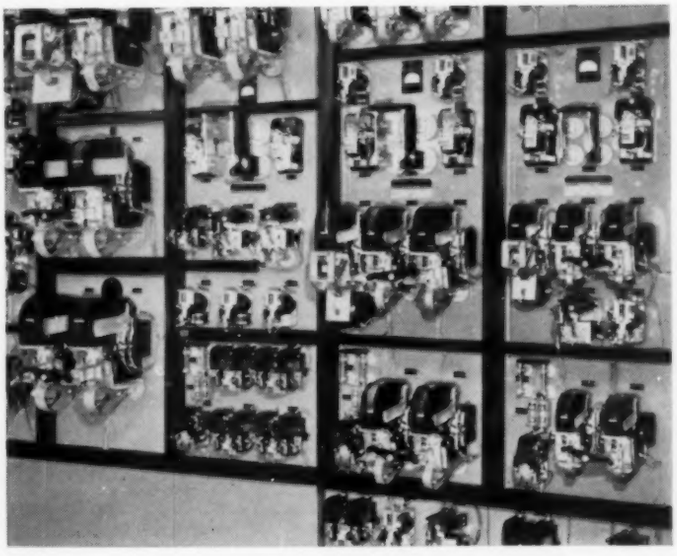
Control wiring in non-inflammable Micarta® channels with snap-off covers provides for easier wiring, tracing, inspection or repair. Stranded wire, highly resistant to vibration, is permanently marked with easy-to-read terminal marking.

Time-Proven Devices are heavy duty, rugged and liberally rated to give longer life for heavy steel mill service.

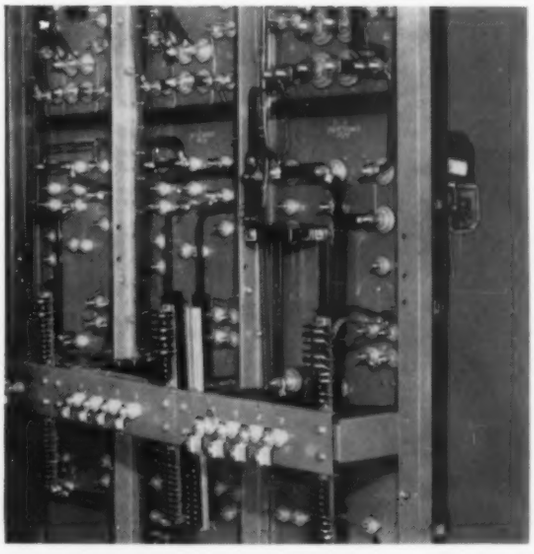
For more information about the new all-steel panel, call your Westinghouse sales engineer. Or write, Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pa.

J-22069

YOU CAN BE SURE...IF IT'S Westinghouse



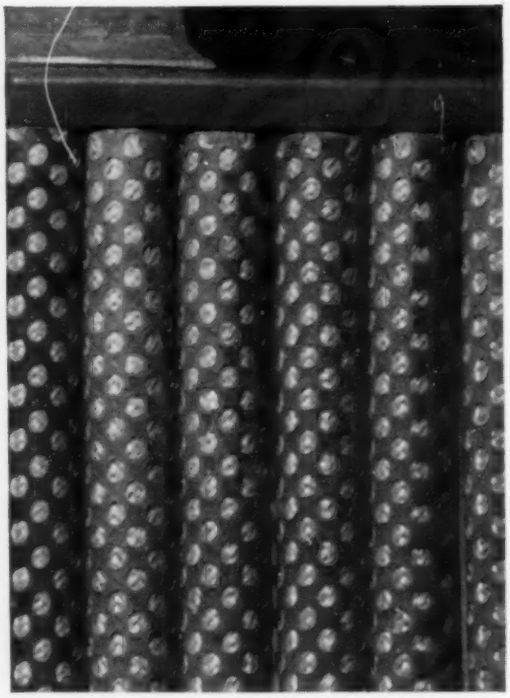
Bonderized light-grey finish of new Westinghouse all-steel panel brightens up entire control panel area — makes all external components easier to see, easier to inspect.



Maximum accessibility is offered with main connections in rear of new steel panel . . . gives more liberal spacing between leads since all control wiring has been removed from rear.

NEW TG EXIDE-IRONCLAD BATTERY SELLING AT RECORD LEVELS

Keeping up with sales. The busy shipping floor at the Exide plant. High volume production insures prompt delivery on all orders.



New tubular construction of positive plate. Holds more active material, gives you highest capacity per cubic inch of any industrial truck battery.

Electric industrial truck users buying it up for "greater economy" and "more power" advantages

Introduced only last April, the new TG Exide-Ironclad Battery is already selling at a faster rate than previous model Exides ever did in a similar period. Indications are that it is on its way to being the biggest selling electric industrial truck battery in history.

Experienced electric industrial truck users are the major buyers —the men who know batteries and see in the TG more value for their money. But in addition, there are truck users who are switching to this TG Exide-Ironclad Battery from cheaper but less economical makes.

If you want maximum economy and better performance in the operation of your electric industrial trucks, get the new TG Exide-Ironclad Battery. You can have more capacity in the same size or the same capacity in a smaller size at a lower cost. Call your nearby Exide representative. Or write for detailed bulletin. Exide Industrial Division, The Electric Storage Battery Company, Philadelphia 2, Pa.

Exide®

The Electric Storage Battery Company

978

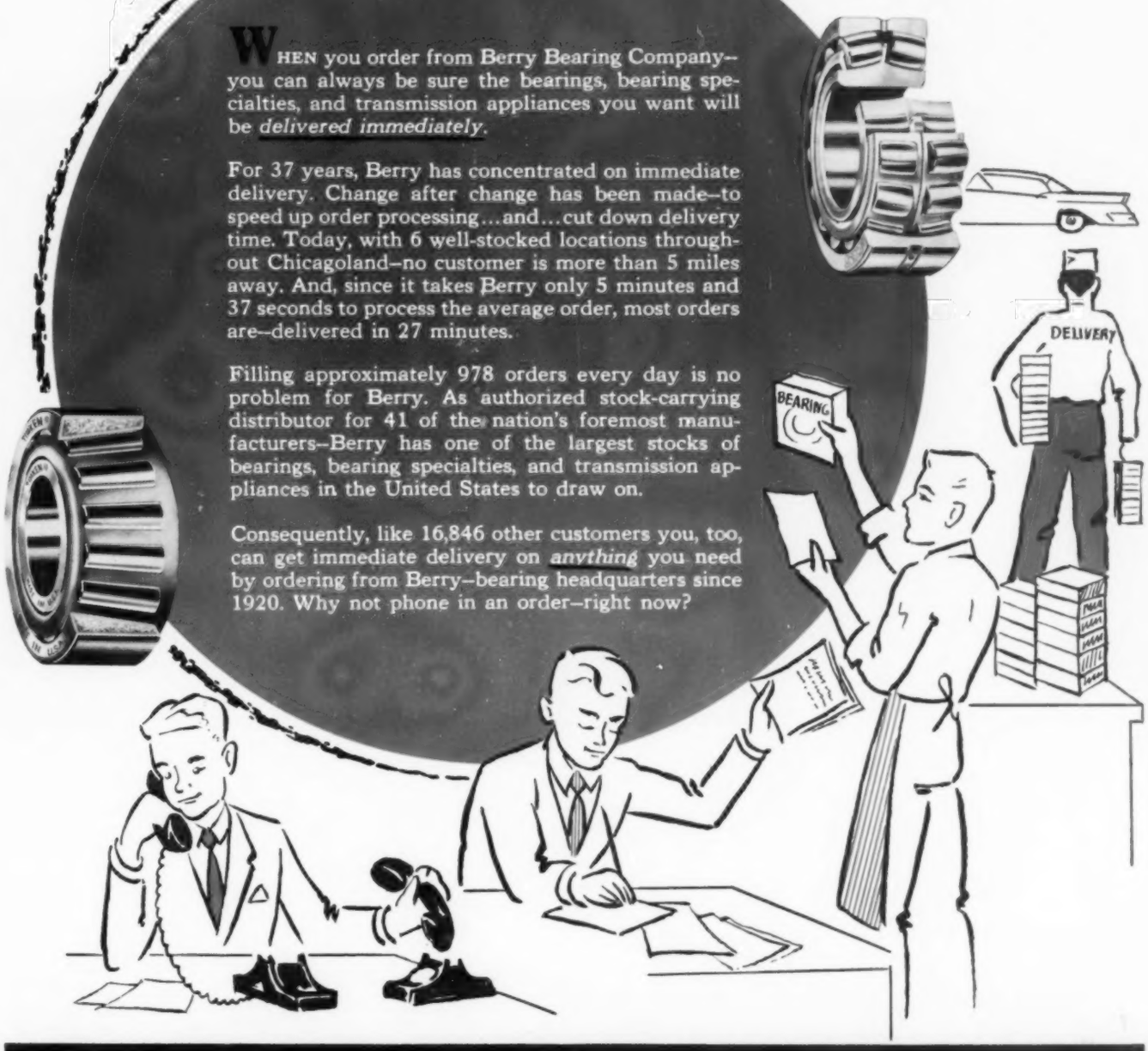
ORDERS FILLED EVERY DAY

WHEN you order from Berry Bearing Company--you can always be sure the bearings, bearing specialties, and transmission appliances you want will be *delivered immediately*.

For 37 years, Berry has concentrated on immediate delivery. Change after change has been made--to speed up order processing...and...cut down delivery time. Today, with 6 well-stocked locations throughout Chicagoland--no customer is more than 5 miles away. And, since it takes Berry only 5 minutes and 37 seconds to process the average order, most orders are--delivered in 27 minutes.

Filling approximately 978 orders every day is no problem for Berry. As authorized stock-carrying distributor for 41 of the nation's foremost manufacturers--Berry has one of the largest stocks of bearings, bearing specialties, and transmission appliances in the United States to draw on.

Consequently, like 16,846 other customers you, too, can get immediate delivery on *anything* you need by ordering from Berry--bearing headquarters since 1920. Why not phone in an order--right now?



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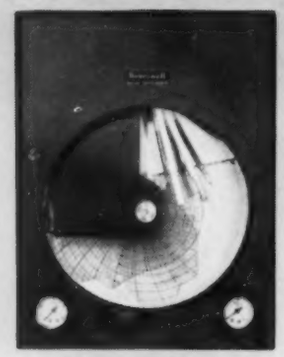
LUdlow 5-4400	EUclid 6-1700	ORchard 4-6600	Phone 2-5561	WEstmore 1-3010	TUrner 5-7501



Integral Cam Programmer . . . Enables complete 1-to-24 hour program to be precast. Electric or pneumatic control on one or both pens.

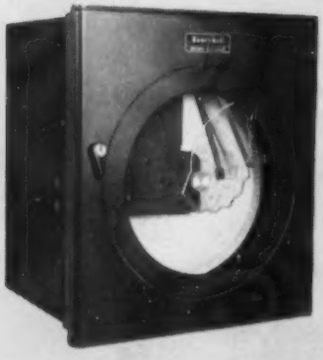
Millivoltmeter Pyrometer—Vertical Case . . . Available in a variety of electric control forms.

Flame Safeguard Relay . . . Stops flow of fuel into combustion space when flame or ignition fails.

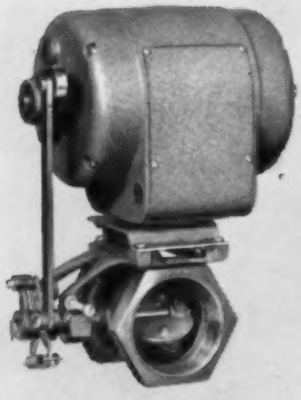
Millivoltmeter Pyrometer—Horizontal Case . . . Fits standard relay rack for easy mounting. Also available with dual set point.

ONE

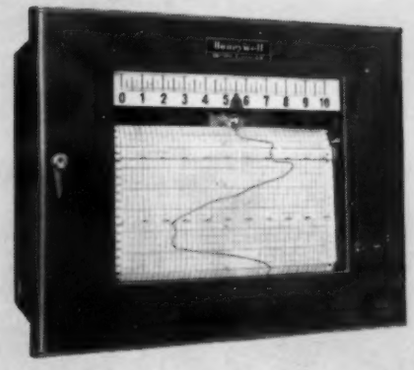
Radiation Detector . . . Responds to 98% of any temperature change within 2 seconds . . . high-speed model responds in half second. For applications from 200 to 7000F.



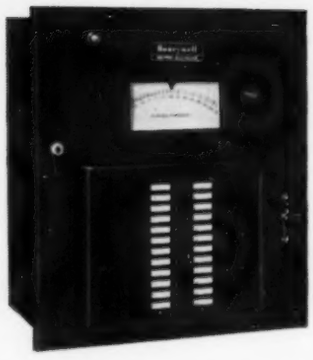
Circular Chart Program Controller . . . With integral cam index guide. Available with electric and pneumatic control forms.



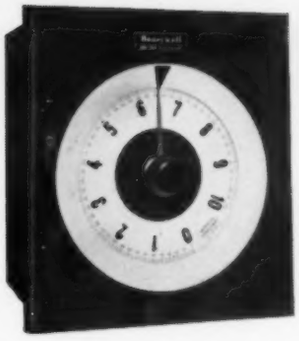
Heavy Duty Electric Motor . . . For operating valves, dampers, louvers and other final control elements.



Strip Chart Recorder—Single or Multiple Point . . . Records all types of variables. Choice of pen speeds and chart speeds.



Precision Indicator—Circular Scale . . . Highly accurate indicator for all variables, one to 48 points.



Circular Scale Controller . . . Scale is over 2½ feet long. Control index rotates with scale for 12 o'clock control check. Available in all electric control forms.

Strip Chart Program Controller . . . Incorporates temperature indication, single or multiple recording, controlling—in one instrument.

STOP shopping...

Whether it's temperature, pressure, flow, or any other important variable you want to measure or control, Honeywell makes just the instrumentation for you. Our line of instruments is as broad as your requirements . . . you can choose exactly what you need.

This means you get all the instrumentation you require from a single source, so there is undivided responsibility for the complete installation. And you are assured that equipment suggested for your process is recommended without bias. With a complete line there is no need to over-sell or under-equip.

For the new process, the modernization program, or a replacement problem, find out how Honeywell can go to work . . . anywhere in the metal processing industry. Get in touch with your nearby Honeywell sales engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Precision Indicator—Vertical Scale . . . Has drum-type power-driven scale. Full scale travel in 12 or 4½ seconds.

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First in Controls

something new in SOAKING PIT CRANES

• This 20-ton telescopic ram soaking pit crane is designed to afford the operator maximum visibility. The operator is located in an air-conditioned cab attached to the bottom of the crane girder at approximately the center of the span. We also design this type of crane with the operator located on the deck of the trolley where he is best protected from the heat.

The tongs are designed to revolve 360 degrees and with a range to suit your ingot sizes.

The torque required to revolve the tongs is transmitted through the hollow square telescopic tubes. These flexibly connected tubes are designed with sufficient strength to safely tip the trolley.

Alliance engineers specialize in designing BIG material-handling equipment. Consult them. They'll help you work out practical, efficient solutions to your handling problems.

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THE Alliance MACHINE COMPANY

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Personnel News...

C. T. Stott, an assistant general manager since 1953, has been named general manager of Bethlehem Steel Co., Sparrows Point Plant, succeeding **C. E. Clarke,** who has retired.

Mr. Clarke was first employed by Bethlehem Steel in 1909, when he entered the engineering department of the Cambria steel plant at Johnstown, Pa., now a Bethlehem property. He became assistant general manager at Sparrows Point in 1926 and held this position until July, 1946, when he was made general manager of the company's plant at Steelton, Pa. He returned to Sparrows Point as general manager November 1, 1947.

Mr. Stott has been a member of the Bethlehem organization since 1934 and has been assigned to the Sparrows Point plant in various capacities since that time. He became the plant's chief metallurgist in 1947 and was appointed an assistant general manager in February, 1953.

Charles M. Beeghly was elected to the board of directors of Jones & Laughlin Steel Corp. Mr. Beeghly is president of the corporation's Strip Steel Division with headquarters in Youngstown, Ohio. He was vice president and general manager of Cold Metal Products Co., which became J & L's Strip Steel Division in July.

Harry H. Northrup, manager of the Buffalo, N. Y., steel plant of Republic Steel Corp., was named manager of the Chicago, Ill., steel plant, succeeding the late **C. P. Cutler.** Mr. Northrup was succeeded as Buffalo manager by **Robert P. Carpenter,** who had been superintendent of the Massillon, Ohio, steel plant. Both men have spent their entire business careers with Republic.

Gregor W. Betz has been promoted to chief engineer of all four plants of Wyckoff Steel Co. He succeeds **William C. Undercoffler** who retired as chief engineer November 1 after 38 years continuous service with the Wyckoff organization.

Frank R. Palmer, president of The Carpenter Steel Co. has been named president of the Company's newly acquired Northeastern Steel Corp. Other officers also named to head up the new subsidiary, now officially known as Carpenter Steel of New England, Inc., include **John Moxon,** executive vice president; **Arlington A. Britton, Jr.,** vice president—production; and **Dr. Carl B. Post,** vice president and technical director.

Harold A. Muttach, divisional superintendent of coke ovens, blast furnaces, open hearth furnaces and foundry at Granite City Steel Co. was promoted to works manager. This position has been vacant for the last year. **Frank J. Burgert,** who has been Mr. Muttach's assistant, was promoted to succeed him. **Joseph F. Tepolt,** tin house superintendent, was promoted to superintendent of the cold strip department. Mr. Muttach went to work for what is today Granite City's blast furnace divison in 1924, when it was the St. Louis Coke and Chemical Co. Before becoming a divisional superintendent, he was, successively, a powerhouse engineer, powerhouse superintendent, a blast furnace turn foreman, assistant blast furnace superintendent, and general superintendent and plant manager at the blast furnace division. Mr. Burgert started at Granite City Steel in 1951 as a junior industrial engineer. In 1954, he was promoted to superintendent of the company's North Plant, and in 1956 he became assistant to Mr. Muttach. Mr. Tepolt started with Granite City Steel in 1923 in the department of metallurgy and inspection. He became tin house superintendent in 1945.

Robert A. Woofter, has been promoted to metallurgical contact engineer for Jones & Laughlin Steel Corp.

Frank N. Nolan has been appointed superintendent of maintenance of the Buffalo steel plant of Republic Steel Corp. A veteran of 40 years' service with Republic and predecessor companies, Mr. Nolan was named general foreman of the mechanical and electrical department in 1935. In 1951, he was promoted to superintendent of the mechanical department.

Karl W. Matthes has been appointed divisional staff engineer for Kaiser Steel Corp.'s general planning division. Formerly a project engineer with Kaiser Engineers Division of Henry J. Kaiser Co., Mr. Matthes has been associated with the steel and metal-

C. T. STOTT

C. M. BEEGHLY

H. H. NORTHRUP

R. P. CARPENTER

K. W. MATTHES

JAMES KING, Jr.

J. M. SCHREINER

M. M. RAND

working industries since 1940. He was a design engineer in Pittsburgh, Pa., for six years with U. S. Steel Corp. and four years with the Koppers Co.

James King, Jr., was named sales manager of electrode products, National Carbon Co., Division of Union Carbide Corp. Mr. King joined National Carbon in 1939, and has most recently served as central division manager of electrode product sales in Chicago. **John M. Schreiner** was named central division manager of electrode product sales. He joined National Carbon in 1947. In 1955 he was named Pacific division manager of electrode product sales, with headquarters in San Francisco, from which position he comes to his new assignment. **M. M. Rand** was appointed Pacific division manager of electrode product sales. He joined National Carbon in 1948, and has most recently served as electrode products representative in Detroit.

Edward W. Moffitt has been appointed general manager of the Bridgeport, Conn., plant of Heppenstall Co. Mr. Moffitt started at the plant in 1955 and served previously as manager of sales production and metallurgy. He came to Heppenstall after 15 years service with the Camden Forge Co., where he rose to be assistant to the vice president in charge of metallurgy.

Johan C. H. Larsen was named to the position of assistant sales manager, The Adalet Manufacturing Co. Prior to his recent promotion, he was factory sales representative for the past eleven years. Before joining Adalet, Mr. Larsen's experience was in sales distribution of mill supplies.

William L. Wearly was elected president of Joy Manufacturing Co. **A. B. Drastrup** was elected excutive vice president to fill the position formerly held by Mr. Wearly. Mr. Wearly has been with the company for 20 years, starting his career in the operating department of the company's Franklin, Pa., plant. He later became vice president in charge of sales, and for the past 2 years has been executive vice president. Mr. Drastrup has been manufacturing vice president and assistant to the president. In addition he has worked in administration of the company's foreign subsidiaries and overseas operations.

T. F. Kaveney has joined the sales department of Electro Metallurgical Co., and has been assigned to the Electric Furnace Section of the Metallurgical Service Division in Cleveland, Ohio. Mr. Kaveney served previously as a metallurgist with Allegheny Ludlum Steel Corp. and Northeastern Steel Corp.

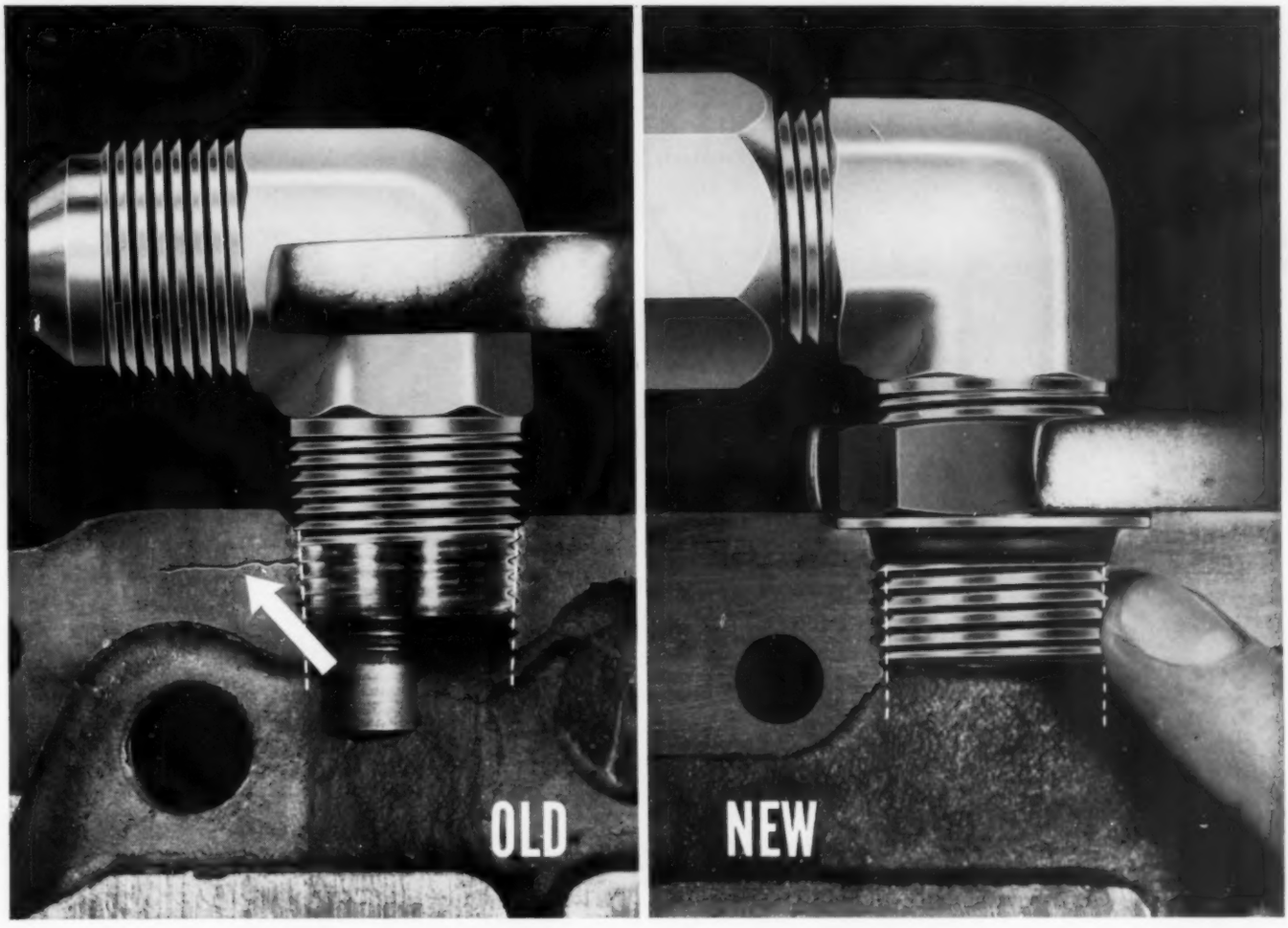
Ralph H. Ehlers was named engineering representative for Wall Colmonoy Corp.'s Morrisville, Pa., plant.

Matthew A. Carpenter was elected chairman of the board and **Harold F. Falk,** president, of the Falk Corp. Mr. Carpenter, chairman of the executive committee since 1953, has been associated with the company for 35 years. During his career with the

H. F. FALK

company he has been sales promotion manager, sales manager and executive vice president. He will continue as chairman of the executive committee. Mr. Falk succeeds his late father, **Harold S. Falk,** as president. He has been executive vice president for the past four years. He has served as general superintendent, works manager and vice president. He established the company's welding division in 1937.

W. F. Stowasser has been named process development engineer in Allis-Chalmers Manufacturing Co.'s Processing Machinery Department. He will also su-



How Parker straight-thread fittings solve leakage problems

Forget about danger of cracking or distorting valve bodies by over-tightening the fittings. Forget about messy pipe "dope." Forget about leakage problems resulting from tapered pipe threads in high-pressure hydraulic systems.

Eliminate these problems. Use Parker O-ring seal straight-thread fittings (which conform with the SAE Standard for Hydraulic Tube Fittings) for leakproof, trouble-free connections. Available on Parker *Triple-lok* (the industrial standard flare tube fitting) and on Parker *Ferulok* (flareless fitting for heavy steel tubing).

Ask your Parker Distributor today, or mail the coupon for complete information about Parker straight-thread fittings.

PARKER FITTINGS AND HOSE DIVISION

Parker Hannifin
creative leader in fluid systems

New, Broader Line of *Hoze-lok* fittings for medium- and high-pressure hydraulic service. Longer performance, greater re-usability. No skiving of hose. Easier make-up saves time and money.

PARKER FITTINGS AND HOSE DIVISION
Section 436-T
Parker-Hannifin Corporation
17325 Euclid Ave., Cleveland 12, Ohio

Please send:
- ☐ *Triple-lok* Fitting Catalog 4310
- ☐ *Ferulok* Fitting Catalog 4320
- ☐ *No-Skive Hoze-lok* Catalogs 4433 & 4434

Name_____ Title_____
Company_____
Address_____
City_____ State_____

pervise operation of the company's Carrollville pilot plant. **W. A. Shockley,** who had been an application in the Crushing Machinery Section, becomes supervisor of Minerals Processing Machinery Sales.

Paul A. Christenson was named to the newly created post of works manager in the expanded operations of the industrial controller division, Square D Co.

P. A. CHRISTENSON

Mr. Christenson joined Square D as a production clerk in 1943, successively holding the positions of sales engineer, order supervisor and production manager.

Philip J. Berg has been named sales manager, Engineering and Construction Department, Machinery Division of Dravo Corp. Mr. Berg was sales manager in the Detroit district from 1953 to 1956 when he returned to Pittsburgh as manager of general construction sales.

R. Wesley Fish has been appointed to the position of sales and service engineer in the Roll Division, United Engineering and Foundry Co. Mr. Fish joined the company in 1931 at its Canton, Ohio, plant and was transferred to the general office sales department in Pittsburgh in 1944. He became supervisor of the order department in 1948 and in 1955 was appointed to the position of sales and service engineer in the Machinery Division, which position he held until the present time.

Arthur F. Uhrlandt has been appointed to the newly created post of director of field sales for Crouse-Hinds Co. Prior to joining the sales staff of Crouse-Hinds' Chicago Division in 1942, Mr. Uhrlandt was associated with Westinghouse Electric Corp., Westinghouse Electric Supply Co., and the Niagara Mohawk Power Corp. In 1951 he was named manager of the Crouse-Hinds Buffalo region, and the following year was transferred to New York City as manager of the Company's Northeast Division, the position he has held to date.

Donald T. Bixby has been named assistant manager of the Standard Products Division of the De Laval Steam Turbine Co. He has been sales manager of the division since 1955. Mr. Bixby joined De Laval in 1945 and served as a sales engineer in the Trenton and San Francisco offices. He was appointed sales manager of the Seattle district office in 1953.

Adrain R. Fisher has become chief executive officer of Johns-Manville Corp. in a realignment of executive responsibilities following retirement of **Leslie M. Cassidy,** chairman. Mr. Fisher also continues as president and director of Johns-Manville, offices which he has held since 1951. Mr. Cassidy continues as a director and will be available to the management as a consultant. **Clinton B. Burnett** was elected executive vice president and was made a director.

Charles A. Schulte was appointed manager of the Vanadium Corp. of America's new Vancoram Plant at Vancoram, Ohio. **Albert J. Primosic** has been appointed manager of the corporation's plant at Niagara Falls, N. Y., to succeed Mr. Schulte.

Alan R. Eakins has been appointed general sales manager, and **H. W. Gethin** named assistant general works manager, Refractories Division, H. K. Porter Co., Inc. Mr. Eakins, promoted from assistant sales manager was previously with General Refractories Co. in various sales positions since 1949. Mr. Gethin has been with Porter's Laclede-Christy Works since 1944, and previous to that, had 14 years of refractories production experience.

P. J. BERG

R. W. FISH

A. F. UHRLANDT

D. T. BIXBY

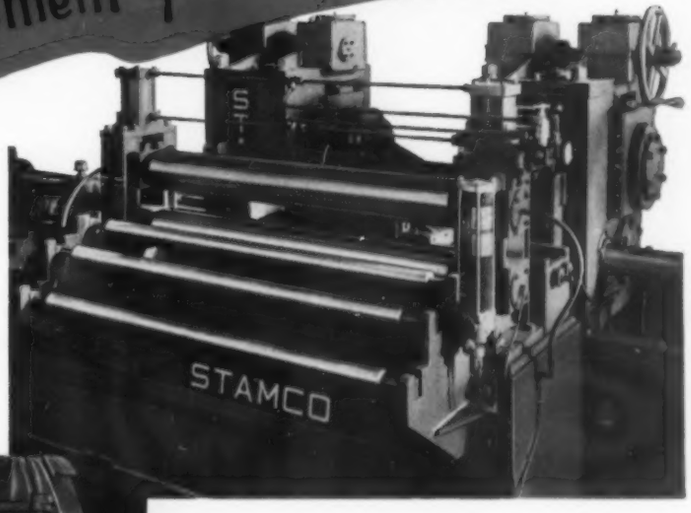
for special steel mill operations

Pickle Line Trimmer

—call or write

Stamco

for the equipment you need



Tin Line Trimmer

Up-Cut Shear

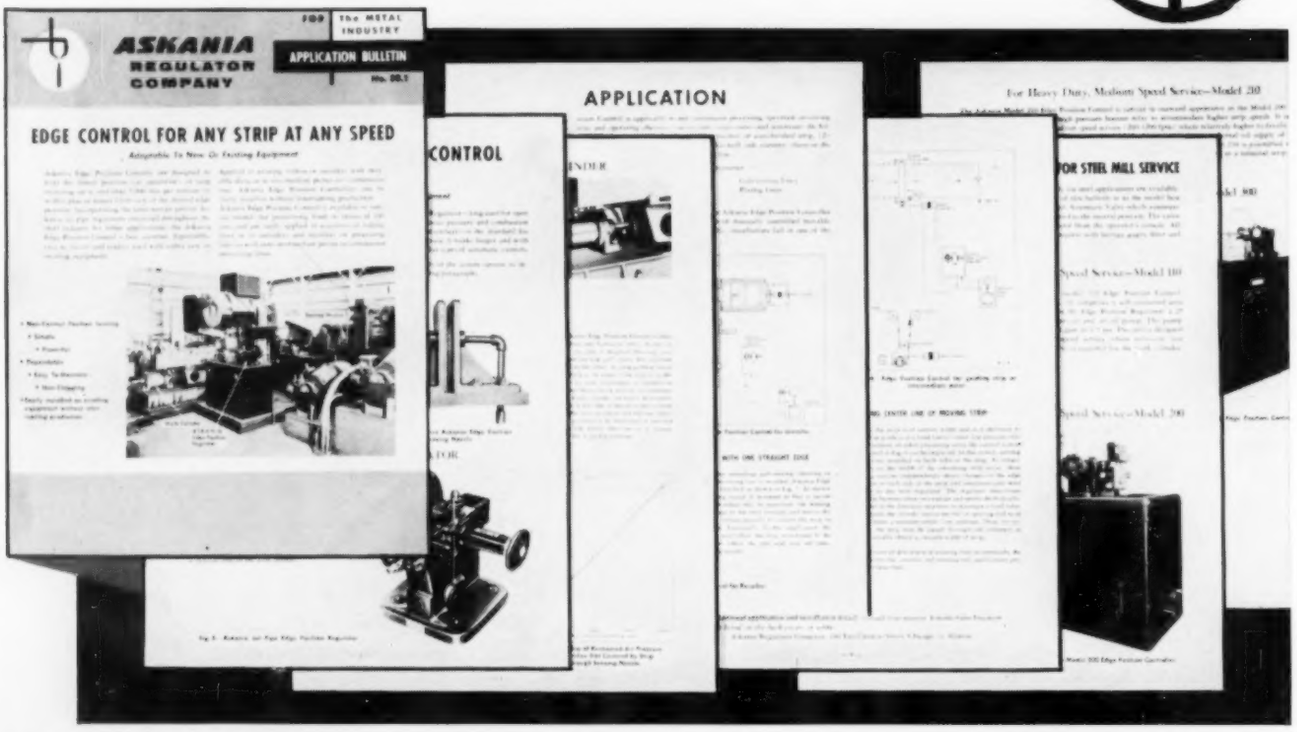
Stamco can solve your problems

Available in a wide range of sizes and speeds for warehouse and mill duty on ferrous and non-ferrous materials. Tell us your needs and we'll give you complete details. No obligation.

Stamco, Inc., New Bremen, Ohio

Askania Regulator Company NEWS

***Automatic Controls for* COMBUSTION • PRESSURE**
FLOW • STRIP EDGE POSITION • STRIP THICKNESS



NEW BULLETIN DESCRIBES HOW AUTOMATIC EDGE CONTROL CAN BE INSTALLED ON NEW *OR EXISTING* STRIP LINE

Explains how it operates Accurately on *Any Strip* at *Any Speed*

ASKANIA REGULATOR COMPANY Bulletin No. 33.1 is now off the press and available to the Metal Industry. It describes performance advantages, applications, method of installation and control, and identifies the specific models from which to select.

It explains how these controls are designed to hold the lateral position (or centerline) of strip traveling up to and over 5,000 feet per minute...to within 0.030 inch of the desired edge position.

Well Illustrated

Bulletin 33.1 contains twelve special diagrams and illustrations. These emphasize the simplicity with which Askania Edge Position Controls are applicable to *any continuous processing operation* involving moving strip.

Some continuous applications are:

Pickling Lines
Annealing Lines
Cleaning Lines
Coating Lines
Slitting Lines
Trimming Lines
Galvanizing Lines
Plating Lines

Do you have these problems?

The four basic categories of Askania Edge Position Controls are explained in detail. These are:

1. Uncoiling strip for delivery at a constant edge position
2. Recoiling strip with one straight edge
3. Guiding strip at intermediate points along continuous lines
4. Guiding center line of moving strip

Are you familiar with these variations?

Model 110—For Light Duty, Medium Speed Service
Model 200—For Heavy Duty, Slow Speed Service
Model 210—For Heavy Duty, Medium Speed Service
Model 300—For Heavy Duty, High Speed Service

Inform Yourself

It pays to be informed—and Bulletin 33.1 contains the type of information you need. You'll be interested in facts proving the importance of simplicity...non-contact operation...ease of maintenance...non-clogging—easy installation, etc. as exemplified by ASKANIA EDGE POSITION CONTROLS.

Send for YOUR copy Today

Write Askania Regulator Company, 246 E. Ontario St., Chicago 11, Ill.

ASKANIA REGULATOR COMPANY
"CONTROLS FOR INDUSTRY"
HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS

A SUBSIDIARY OF GPE

John L. Cross has been appointed industrial sales manager for the Westinghouse Electric Corp.'s atlantic apparatus sales region in Philadelphia, Pa. Mr. Cross entered the Westinghouse student training course in 1933. He later held various sales posts in the New York sales office and the transformer division in Sharon, Pa. In 1941 Mr. Cross became manager of power equipment sales at the Sharon works, and in 1957 until his present assignment he served as assistant sales manager of apparatus products at Westinghouse headquarters in Pittsburgh.

A. F. Skipp, Jr., was named sales manager of the Herr Equipment Corp. After having been affiliated with Gulf Refining Co., and spending three years with the Westinghouse Electric Corp., Mr. Skipp joined Herr as sales engineer in 1956.

Obituaries

John H. Vohr, general superintendent, United States Steel Corp., Gary Steel Works, Gary, Ind., and past president of AISE, died December 1.

Mr. Vohr joined the American Sheet and Tinplate Co. at Farrell, Pa., in 1919, working up to master mechanic, before being transferred to Gary as night superintendent of the 42-in. strip mill. He left American Sheet and Tinplate in 1931 and worked on the installation and operation of the new strip mills of the Inland Steel Co., and Youngstown Sheet and Tube Co.

JOHN H. VOHR

In 1936 Mr. Vohr went with Granite City Steel Co., Granite City, Ill., as superintendent of the hot and cold strip mills and in 1937 was made general superintendent. In 1942 he joined the Carnegie-Illinois Steel Corp., working in the general offices in Pittsburgh until his appointment in 1943 as assistant general superintendent of South works at Chicago, Ill. In 1949 he was promoted to general superintendent of the Gary Steel works.

Mr. Vohr served as president of the Association of Iron and Steel Engineers during 1955.

Charles P. Cutler, 62, manager of Republic Steel Corp.'s South Chicago steel district died Nov. 8. Mr. Cutler, whose career in the steel industry extended 48 years with Republic and its predecessor company in Chicago, had been manager of Republic's South Chicago operations since May, 1945. He began his career in the steel industry as an office boy at the Interstate Iron and Steel Co. plant in East Chicago in 1909. Fifteen years later, he was named plant manager there. In 1931, Mr. Cutler was transferred to Republic's South Chicago plant as assistant superintendent of rolling, finishing and special process departments. He was appointed superintendent of these operations in 1934 and named assistant district manager in February, 1942.

John J. Dowdle, III, a vice president of Great Lakes Carbon Corp. died November 11. Mr. Dowdle joined Great Lakes Carbon in 1945 as assistant to the general manager, building products, and later became sales representative for the corporation's electrode division. In 1950 he became special assistant to the president. He was elected a vice president of the corporation in 1951.

William Kerr Stamets, founder and chairman of the board of the William K. Stamets Co. and the Enterprise Co., died November 17.

Super Ink Print-All clearly marks all conveyed materials traveling horizontally or vertically. It prints top or bottom surfaces as material moves under or over the printer.

Write for complete data.

PANNIER'S ALL-NEW SUPER INK PRINT-ALL

Internally fed unit.
Use inks from semi-paste to liquid, including light colored, heavy pigmented inks.
Continuous or repeat printing.
No stopping to add ink.
Print on 1" centers with multiple staggered units.

BIRTHMARKED MATERIALS

MARKING DEVICES

THE PANNIER CORPORATION

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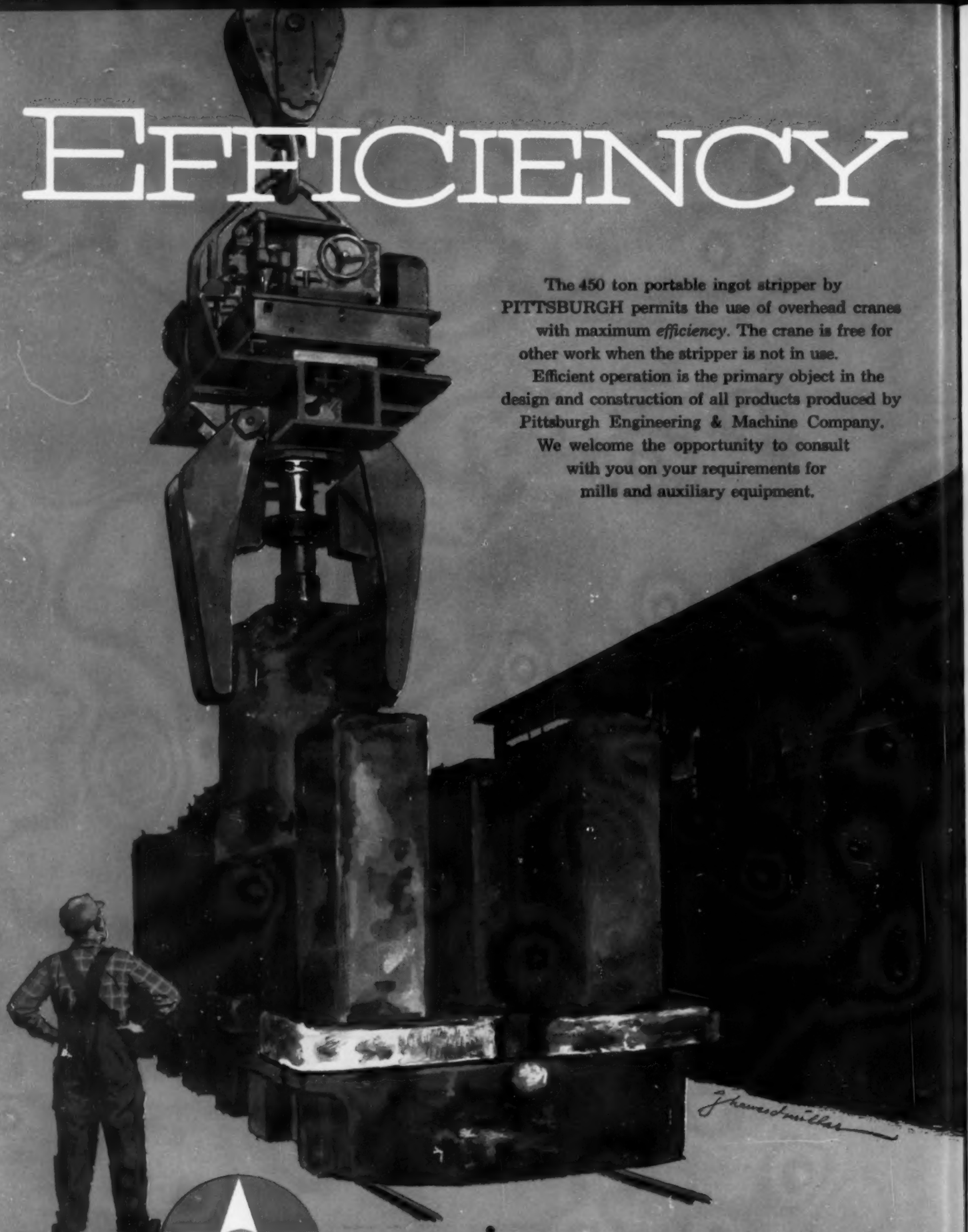
EFFICIENCY



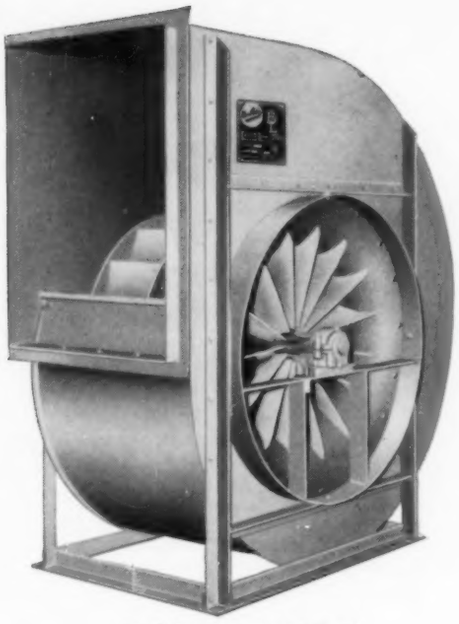
The 450 ton portable ingot stripper by PITTSBURGH permits the use of overhead cranes with maximum *efficiency*. The crane is free for other work when the stripper is not in use.

Efficient operation is the primary object in the design and construction of all products produced by Pittsburgh Engineering & Machine Company. We welcome the opportunity to consult with you on your requirements for mills and auxiliary equipment.

Pittsburgh
ENGINEERING & MACHINE CO.

P. O. BOX 986, PITTSBURGH 30, PENNSYLVANIA
PLANT AT GLASSPORT, PENNSYLVANIA
Division of Pittsburgh Steel Foundry Corporation

"Electric and Open Hearth Steel Castings from 1 lb. to 100 tons"



(Buffalo Type "BL" Fan)

HOW "BUFFALO" FANS GIVE YOU MORE ECONOMICAL MILL MOTOR COOLING

Ventilation for motor rooms and motors presents a potent challenge to any fan. It's a continuous high-temperature air moving operation... 24 hours a day, day in and day out, year in and year out.

"Buffalo" Fans are built to stand up under this kind of punishment. Take the type "BL" Fan, shown above. Its rugged, durable construction features insure you a long life of peak heavy-duty performance with a minimum of maintenance.

These "Buffalo" features include over-sized, self-aligning bearings — heavy plate housing — rigid plate wheel with husky hub, back plate and die-formed blades. You're sure of full-rated-delivery-on-the-job because of the exclusive "Buffalo" design of the complete unit... from fixed inlet guide vanes through the wheel to the discharge.

These are all good reasons why the "Buffalo" Type "BL" Fan will give you more economical and reliable mill motor cooling. Contact your nearest "Buffalo" Engineering Representative for details, or write for Bulletin F-102.

If your mill motor cooling fans must be placed in a confined area, "Buffalo" Axial Flow Fans are the ones to specify. Their light weight, rigid construction permits economical installation. They effect important space-savings because they fit in snugly to walls, ceilings, or floors. Ideally suited to duct or through-the-wall installation. Either direct or belt drive.

Whether you install your own axial flow fan, or have it installed as a component, be sure you specify "Buffalo" for maximum reliability and economy. Write today for Bulletin 3533-H.

Engineered into every "Buffalo" Fan is the famous "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.

(Buffalo Axial Flow Fan)

"Buffalo"

BUFFALO FORGE COMPANY

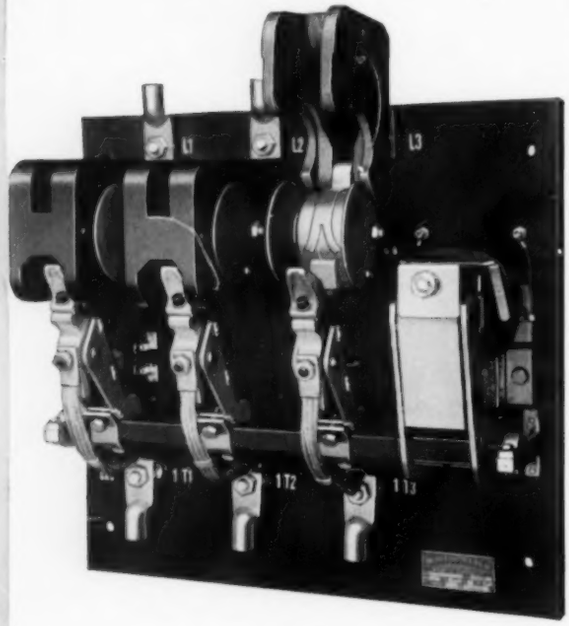
BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING AIR CLEANING AIR TEMPERING COOLING HEATING INDUCED DRAFT EXHAUSTING FORCED DRAFT PRESSURE BLOWING

HEAVY-DUTY

300-AMPERE CONTACTOR



1 *Blows out arc faster.*
2 *Speeds operating cycle.*
3 *Reduces maintenance.*
4 *Operates quietly.*
5 *Lengthens contact life.*
6 *Provides horizontal or vertical mechanical interlocking.*
7 *Combines maximum structural strength with minimum weight.*

While this mill-type contactor was specifically designed for starter, machine-tool and crane applications, it is finding use in all types of service where severe operating conditions place a premium on lasting performance.

WRITE FOR BULLETIN 5005

THE EUCLID ELECTRIC & MFG. CO.
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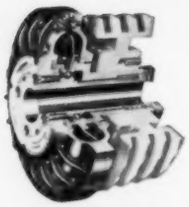

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THE DRY FLUID DRIVE

NEW! REVOLUTIONARY!

Handles difficult starting problems and gives a *new* kind of protection against shock and overloads. The dry flow-charge can be varied to give exact torque you need. When load reaches normal speed there is zero slip, giving 100% efficiency. Write for bulletin with detailed information on Flexidyne Drives and Flexidyne Couplings.

DODGE MANUFACTURING CORPORATION, 5900 Union St., Mishawaka, Ind.

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"MEASURAY"

MEASURES THICKNESS ACCURATELY *without TOUCHING the MATERIAL*

Hot or Cold Strip Steel, Brass, Copper, Aluminum . . . Plastics, Foils, Coated Fabrics, Film, Rubber, Etc., Even When Moving At High Speed.

Simple method—the "Measuray" shoots X-Rays through the material—measures its absorption of the rays. Calibrated meter registers plus or minus per cent of deviation from pre-determined standard. Especially useful on hot mills where material can't be checked by contact gages. Also when material can be deformed by contact such as foil.

"Measuray" is accurate to 1% of thickness or less. Quickly pays for itself in reduced scrap.

Write Today for Literature to Dept. 25, The Sheffield Corporation, Dayton 1, Ohio

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of Bendix Aviation Corporation
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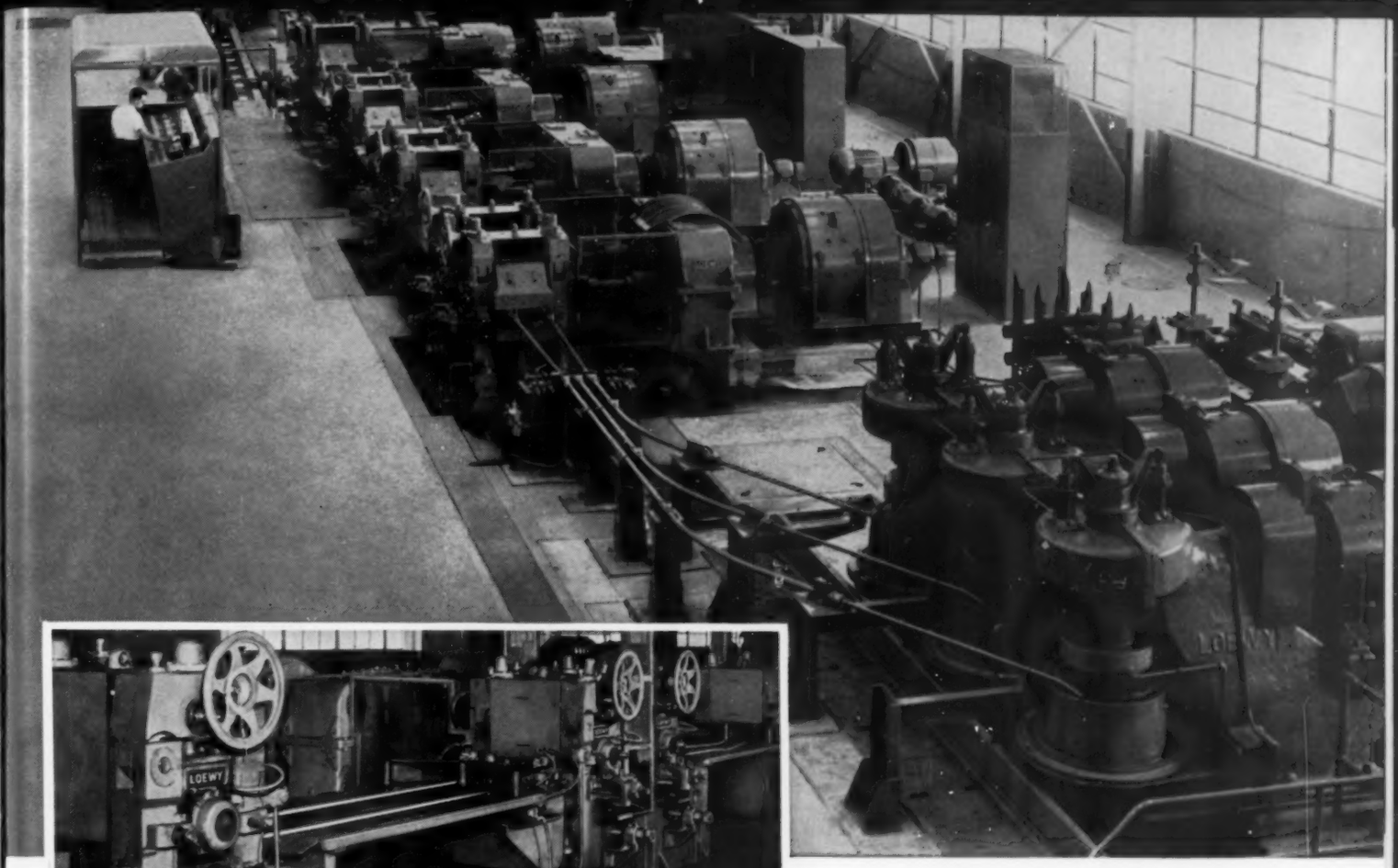
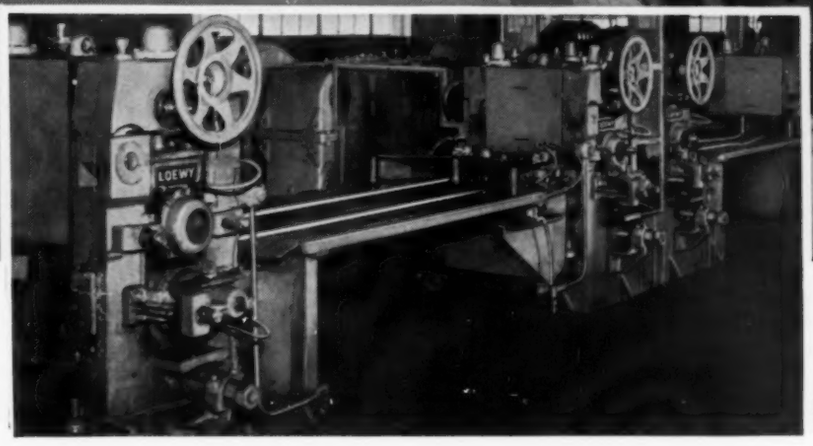


Continuous wire rod mill installation for 2-strand operation.



Part of 12- and 10-in. continuous finishing train of a wire rod mill showing entry side for 2-strand operation.

Even with inexperienced crews, Loewy wire rod mills for steel and nonferrous metals function flawlessly

This automatic rolling mill has been in operation now for one year, and its owner is well satisfied with it in every respect. In addition to the excellent products and high output obtained, he is extremely pleased with the fact that despite the inexperience of the crew assigned to it from the start, the installation has operated without difficulty.

On nonferrous metals, our wire rod mills operate at 2400 fpm and more. On steel, of course, speeds up to 6000 fpm can be obtained. Loewy rolling mills are engineered for top output, labor-saving production, and minimum maintenance.

Loewy designs, builds and installs blooming mills, slabbing mills, hot and cold strip mills, rail and structural mills, billet mills, skelp mills, merchant mills, foil mills, laboratory mills, all kinds of special mills and auxiliary equipment.

We work with you from the earliest planning stage, taking your initial concept and developing it through every phase of the project to full-scale plant operation. We also specialize in modernization of existing rolling mills. If you would like more detailed information, write us today, Dept. C-12.

Loewy-Hydropress Division

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and only USG® brushes have STATITE® permanent shunt connections

If you are having trouble with shunts jarring loose or being pulled out, we suggest you try USG Brushes with Statite. Statite is a permanent shunt connection needing no hammerclips. It can't be jarred out even under severe operating conditions, and will assure your electric motors of steady maintenance-free performance. Statite eliminates the need for riveted shunt connections. In addition, Statite shunt connections retain their original low millivolt shunt drop, cannot oxidize, and are unaffected by temperature extremes. USG Brushes are manufactured in a variety of types and sizes for all applications from fractional horsepower to diesel generator. Grades available include carbon and carbon-graphite, electrographitic, graphite, metal graphite, and silver graphite.

224

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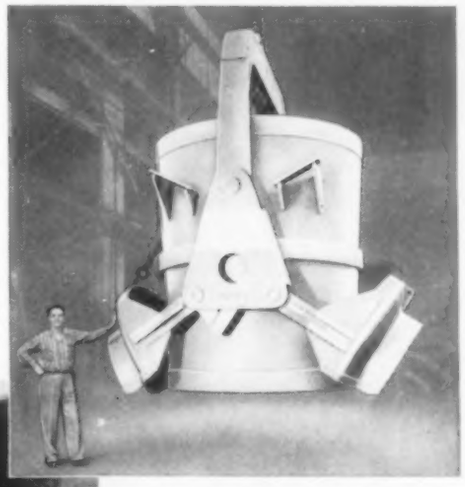
Special indexing machine tool base over ten feet in diameter, weight nearly ten tons.

You name it—and the odds are two to one that McGregor-Michigan is experienced in *your* line. We're turning out an endless miscellany of steel plate fabrications for industries across the nation. As part of the proof of our ability and versatility, here are a few of the products of the manufacturers and processors we're serving:

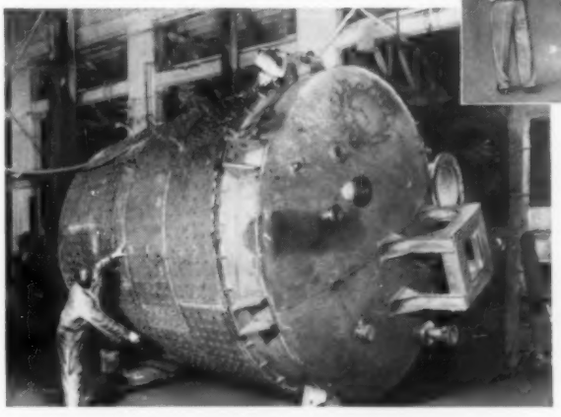
Acids, alkalis, fertilizers, glass, refractories, plastics, petroleum, steel, aluminum, automation and special machinery, explosives, paper, diesels, cement and rock products, coke by-products, leather, soap, tools and dies, textiles—and numerous variations of these.

As further evidence of the reliability of McGregor-Michigan, we're proud to point out that the frequent repeat orders from these fine customers are the surest indication that we've earned their good will. How? By seeing that all factors are in balance: price, quality, delivery and service—for it is only by complete attention to *all* of these that we are able to fully satisfy our many diversified customers.

If you don't see your particular industry included in the list above, think of the many problems these customers have thrown at McGregor-Michigan —then go and do thou likewise.

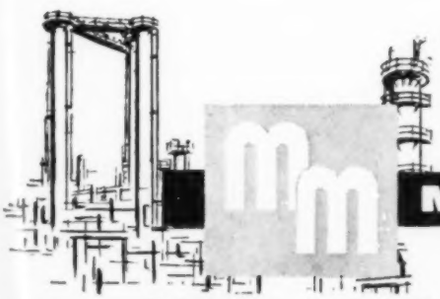


Steel mill scrap bucket. Linkage equalizes opening of clamshell halves.



Stainless steel jacketed chemical mixing kettle. Operates under vacuum and atmospheric pressure, medium high temperatures.

Send for new booklet showing equipment and typical steel plate fabrications.



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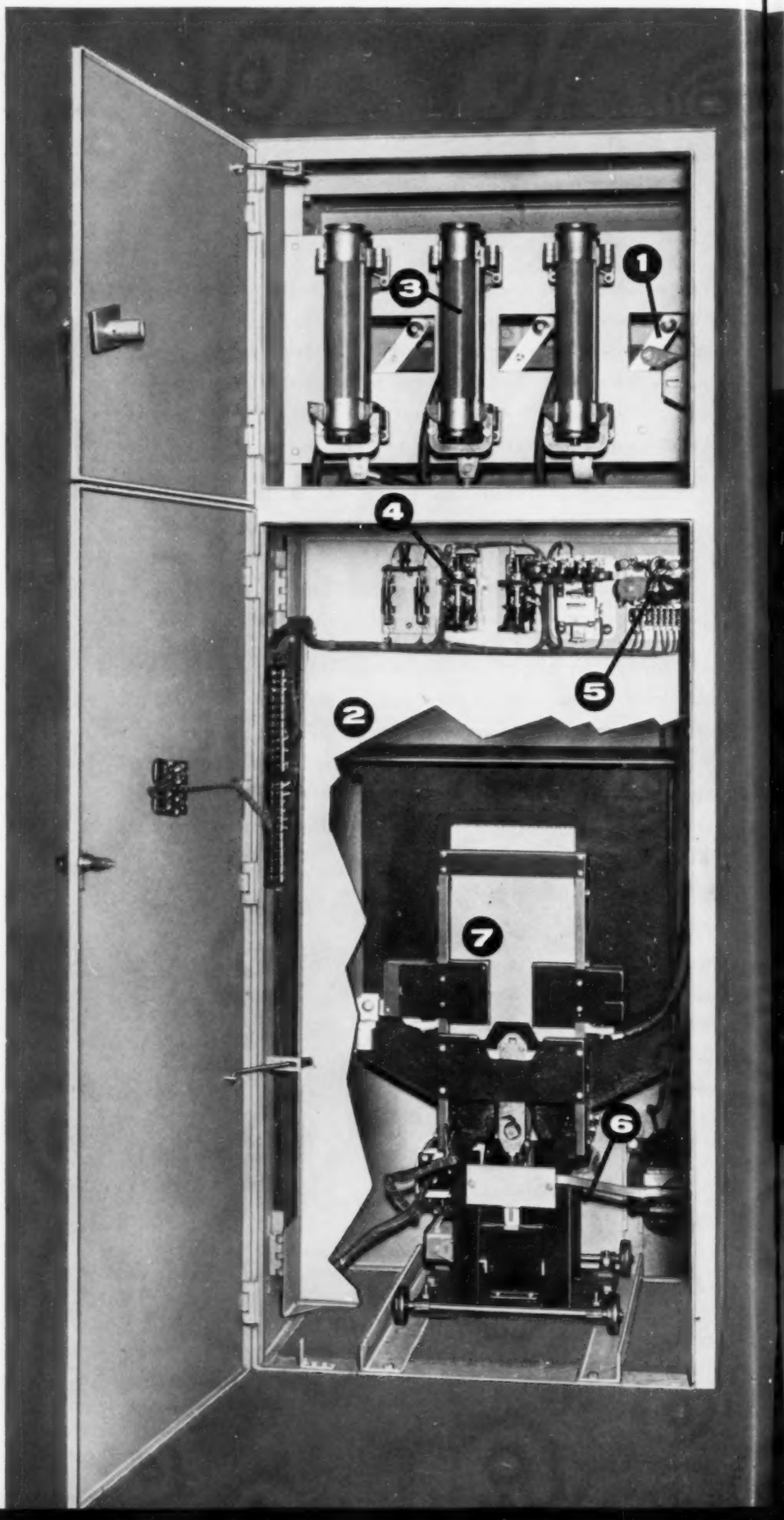
STEEL PLATE FABRICATING AND WAREHOUSING

Allis-Chalmers announces... **Newly**



1

Gang-operated disconnect switch isolates starter from incoming power — assures safe entry of high voltage compartments.

2

Steel cubicle is compartmentalized — separates high and low voltage equipment.

3

Short-circuit protection is provided by fast-acting current-limiting fuses, rated 150,000 kva at 2300 volts and 250,000 kva at 4160 or 4600 volts.

4

Overload protection is handled by accurate relays which trip only on excessive motor current, preventing needless motor stoppages.

5

Undervoltage protection instantaneously opens line contactor on loss of voltage. Time-delay undervoltage protection also available.

6

Mechanical interlock coordinates contactor, disconnect switch, upper door and inner control barrier for maximum safety.

7

Roll-out contactor makes maintenance easy—even in narrowest aisle space. (Routine inspection and maintenance can be done with contactor in place.)

Designed

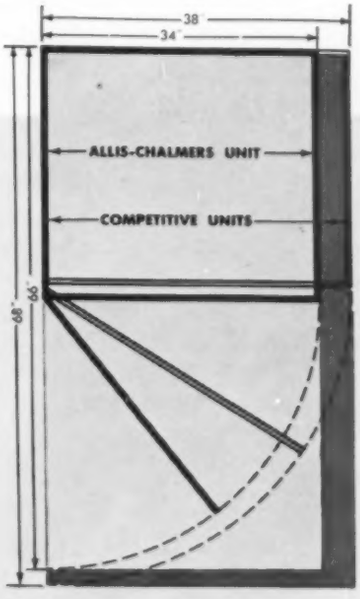
Type H High Voltage Motor Control

Combines front access with space economy...

In addition, you get maximum protection for personnel and machines, thoroughly tested components, and ample panel space for modifications. It's all built into the *smaller cabinet* of a newly designed line of Type H high voltage starters from Allis-Chalmers.

Here is control that couples compactness with roominess (for ease of maintenance) . . . here is a starter that joins test-proven performance with versatility (for addition of meters and relays) — AND the line meets every 2300 to 5000-volt motor need.

For more information on this engineering advance, contact your A-C representative or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.



ALLIS-CHALMERS UNIT requires 2.3 sq ft less floor space than any competitive unit. Put 10 A-C units in the same area needed for 9 cabinets of other manufacture.

Indicates 2.3-sq-ft saving in floor space

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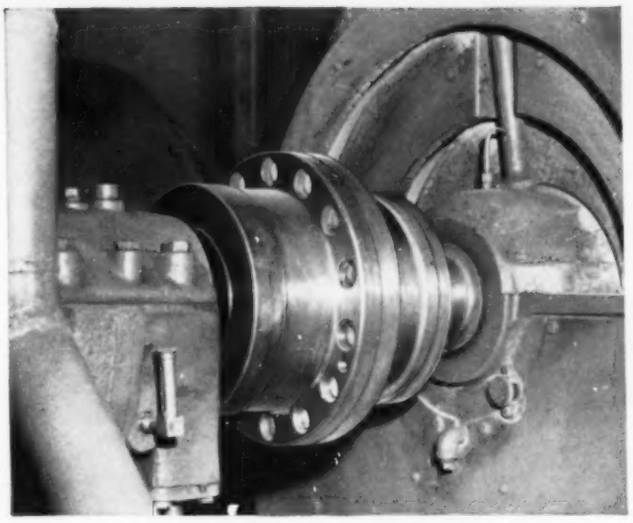
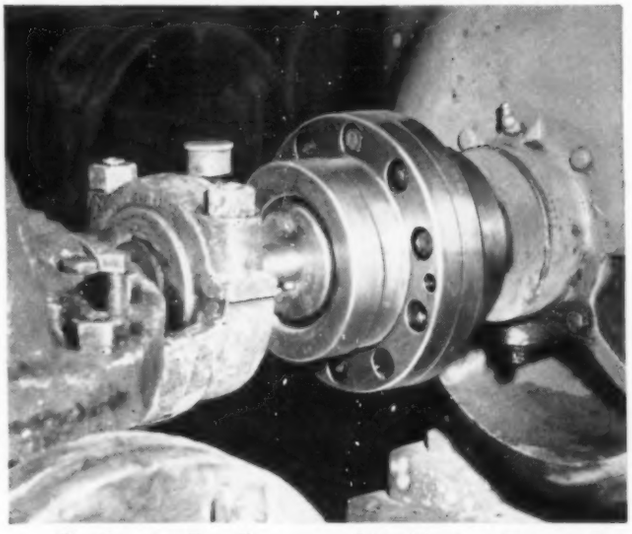
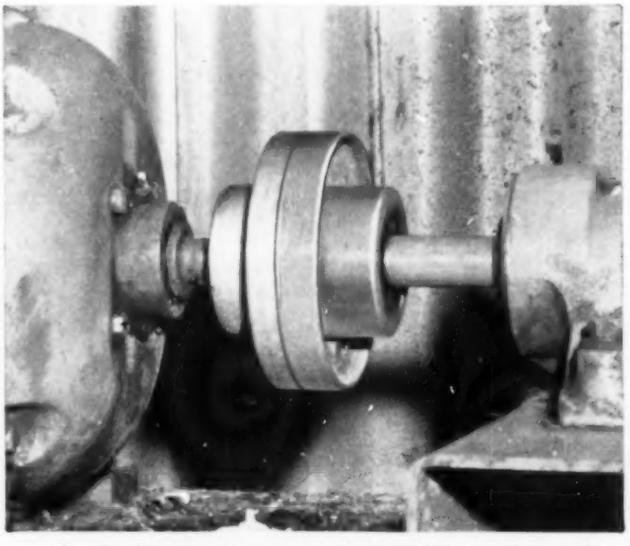


Fast's #4½ Coupling on a 1200 GPM Wilson-Snyder descaling pump. A 1500 hp., 1770 rpm motor drives the unit which operates at a head of 1250′.



Fast's #2 Coupling on a Worthington Type 4-L-1 1000 GPM pump operating at a head of 175′. Pump speed is 3570 rpm. Motor is 60 hp.



Fast's #1 Coupling on a 2500 CFM ventilating fan. Fan motor is 1½ hp. Rpm is 1800.

Detroit Steel Keeps 100 Fast's Couplings at Work with Only Minimum Maintenance

Fast's Couplings have reduced costly downtime and maintenance at Detroit Steel Corporation's Portsmouth, Ohio hot strip mill. Over 100 in number, they range in size from #1 to #20. Many of these couplings have operated with practically no maintenance for six years. Detroit Steel chose Fast's Couplings because of their *sound basic design.*

Here's why Fast's design pays off in low-cost maintenance and trouble-free performance: mechanical flexibility compensates for misalignment. Couplings last longer because there's no metal-to-metal wear. Positive lubrication forms a film on load-carrying surfaces. Metal-to-metal seal keeps out dirt, grit and moisture.

For more details, write to KOPPERS COMPANY, INC., Fast's Coupling Dept., 3012, Scott St., Baltimore 3, Md.

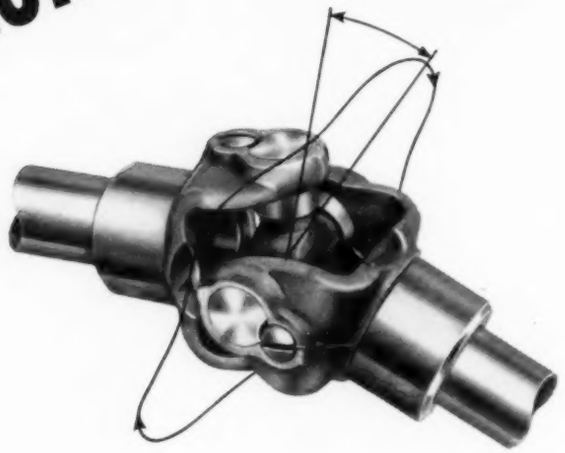
THE ORIGINAL

KOPPERS

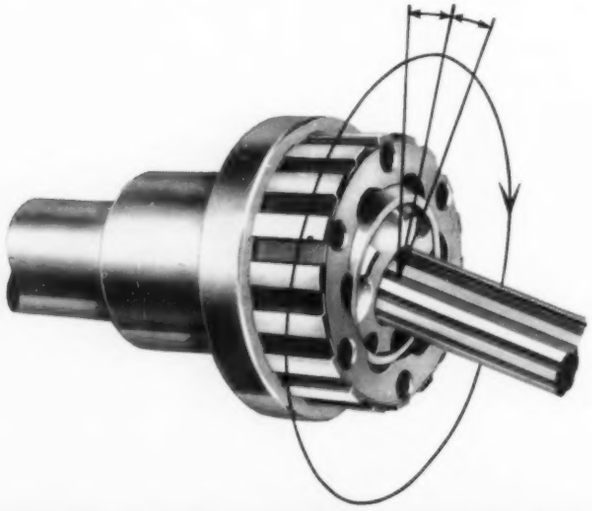
FAST'S Couplings

Engineered Products Sold with *Service*

RZEPPA JOINTS ELIMINATE THE HIGH COST OF "Rock and Roll" Action...



Old-fashioned pin or slipper-type joints speed up, slow down twice during one revolution. What you get is rough and tumble "rock and roll" torque which cuts down joint life, causes vibration.



RZEPPA (PRONOUNCED "SHEPPA") CONSTANT VELOCITY JOINTS ELIMINATE THIS "ROCK AND ROLL" ACTION FOREVER!

Rzeppa Joints transmit 100% smooth torque every minute they are on the job. Operate precision smooth at angles up to 35°. No bounce. No chatter. No vibration. Long life and higher torque capacity are built into every Rzeppa Joint. You get longer shaft life, too.

RZEPPA "SHEPPA" CONSTANT VELOCITY UNIVERSAL JOINTS

THE GEAR GRINDING MACHINE CO.

3929 Christopher, Detroit 11, Michigan

MANUFACTURERS OF: FULLY AUTOMATIC GEAR GRINDING MACHINES: DETROIT SCREWMATIC 750 SINGLE SPINDLE SCREW MACHINES.

57-B

SEND FOR LATEST BROCHURE

—or send us a dimensional sketch along with peak horsepower, operating angles and R. P. Ms. Our engineers will assist in making a proper joint recommendation.

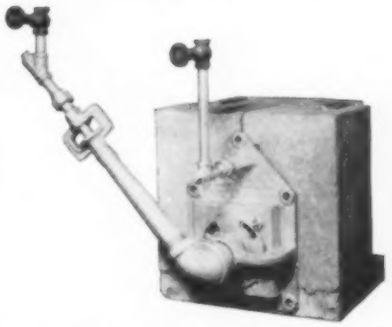
When you want to put the heat on...

■ When you want to put the heat on—use the F.E.I. direct fired burner system. Any cover type annealing furnace performs faster and more efficiently with this patented direct firing system than with radiant tube firing. You can eliminate bothersome, costly tube replacement. . .get greater heating efficiency. . .faster heat-up and eliminate expensive "downtime" interruptions by putting heat *directly* inside the furnace—where it does the most good!

Use the F.E.I. direct firing burner system on your new annealing furnaces or convert present furnaces to this highly efficient system. Nearly 200 cover type annealing furnaces have already been converted to the F.E.I. direct fired system.
Contact an F.E.I. furnace specialist—today!

F.E.I. Under New Management

Furnace Engineers is now under the management of Mr. A. A. Straub and his associates. All patents, engineering information and key personnel will remain with the firm. Financial management and sales policies have been modernized in line with present day business standards.



Typical F.E.I. Burner Assembly—the heart of any direct fired furnace. It is sturdy, automatically controlled and efficient to operate.

FURNACE ENGINEERS—designers and rebuilders of direct fired furnaces.

- Cover Type Annealing Furnaces
- Car Type Annealing Furnaces
- Galvanizing Settings
- Patenting Furnaces
- Regenerative Soaking Pits

Furnace Engineers, Inc.

214 BOULEVARD OF THE ALLIES • PITTSBURGH 16, PA.

Write For This Descriptive Bulletin—

PRECISION-ENGINEERED

meets highly exacting standards

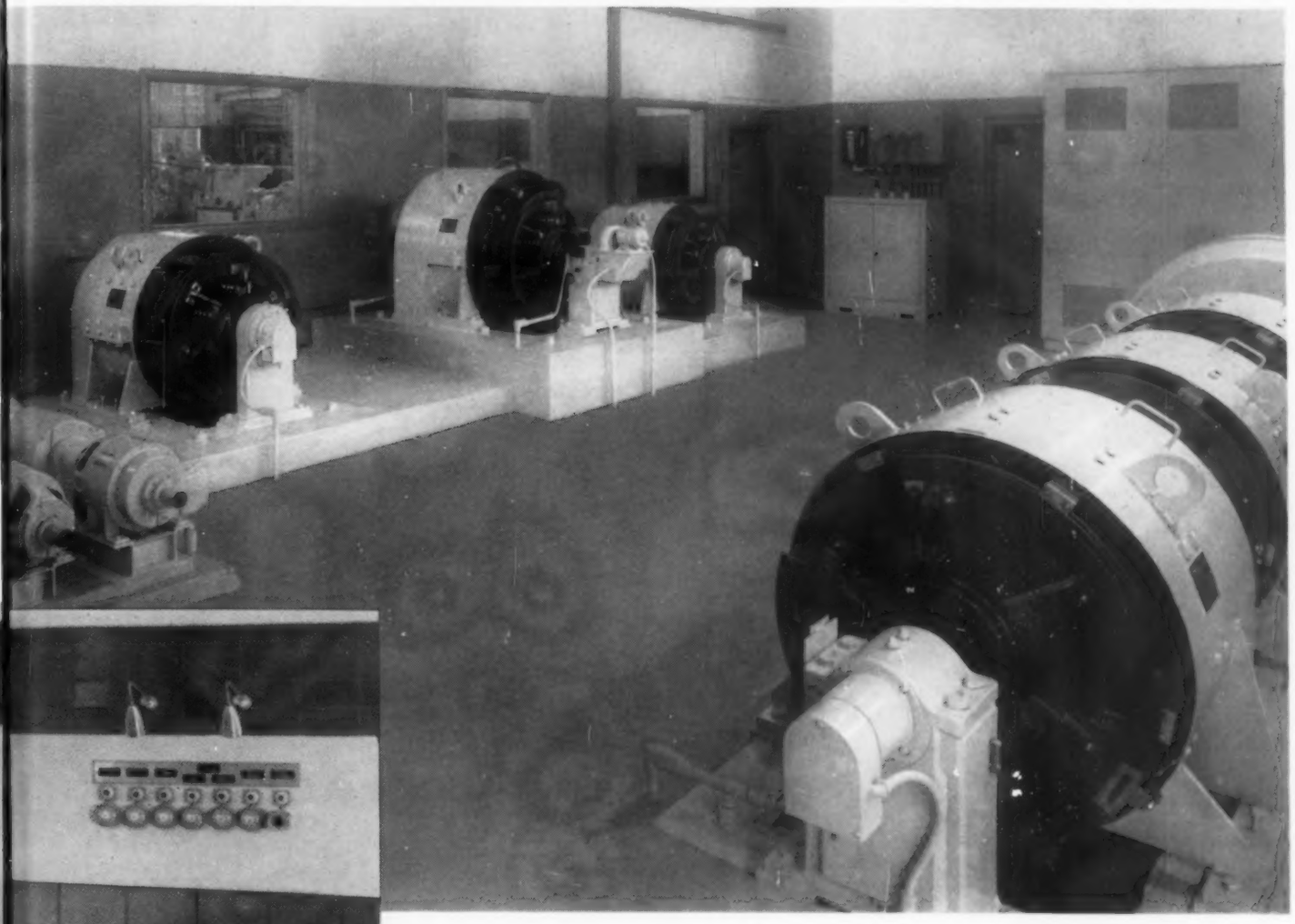
of new Somers Brass Sendzimir Mill

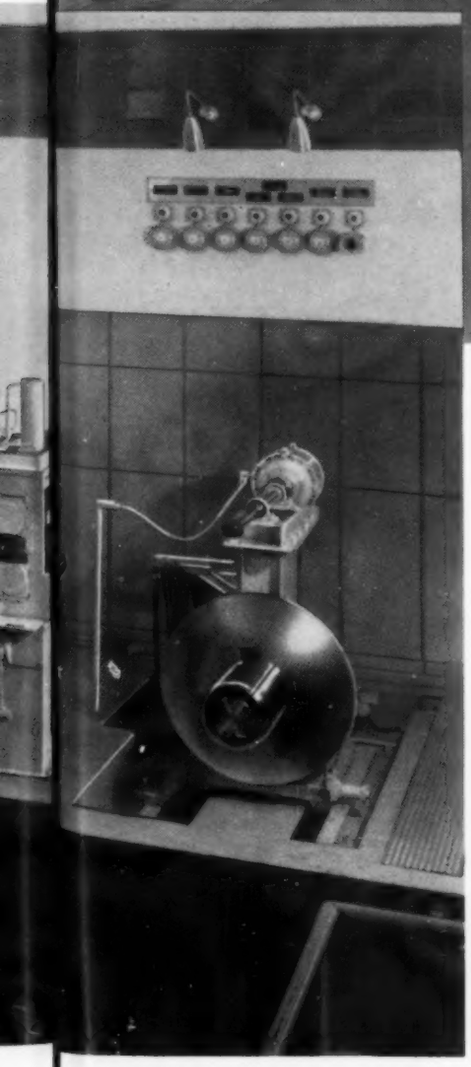
Match precision-engineered Elliott drives to the highly exacting standards of today's modernized rolling mills and you have a winning combination . . . just what you need to keep pace with accelerated tonnage requirements and for quality control.

A typical example of Elliott's contribution in this field is the new Sendzimir cold strip mill seen below, recently installed by the Somers Brass Company in Waterbury, Connecticut. This mill—one of the largest in the non-ferrous industry—is a precision mill requiring precision equipment. Elliott engineered the complete drive including an ingenious arrangement of control equipment which regulates the speed relationship between main rolls and the reels.

The Elliott equipment shown in the photo at the right, includes a 500-hp, 500/900-rpm, 250-volt d-c motor which drives the work rolls, and two 350-hp, 400/800-rpm motors which drive the winding reels. Adjustable voltage power for these motors is supplied by a 5-unit, 725-kw Elliott motor-generator set driven by a 1000-hp, 2300-volt synchronous motor. All main drive machines are built with enclosures for updraft forced ventilation.

ELLIOTT DRIVE

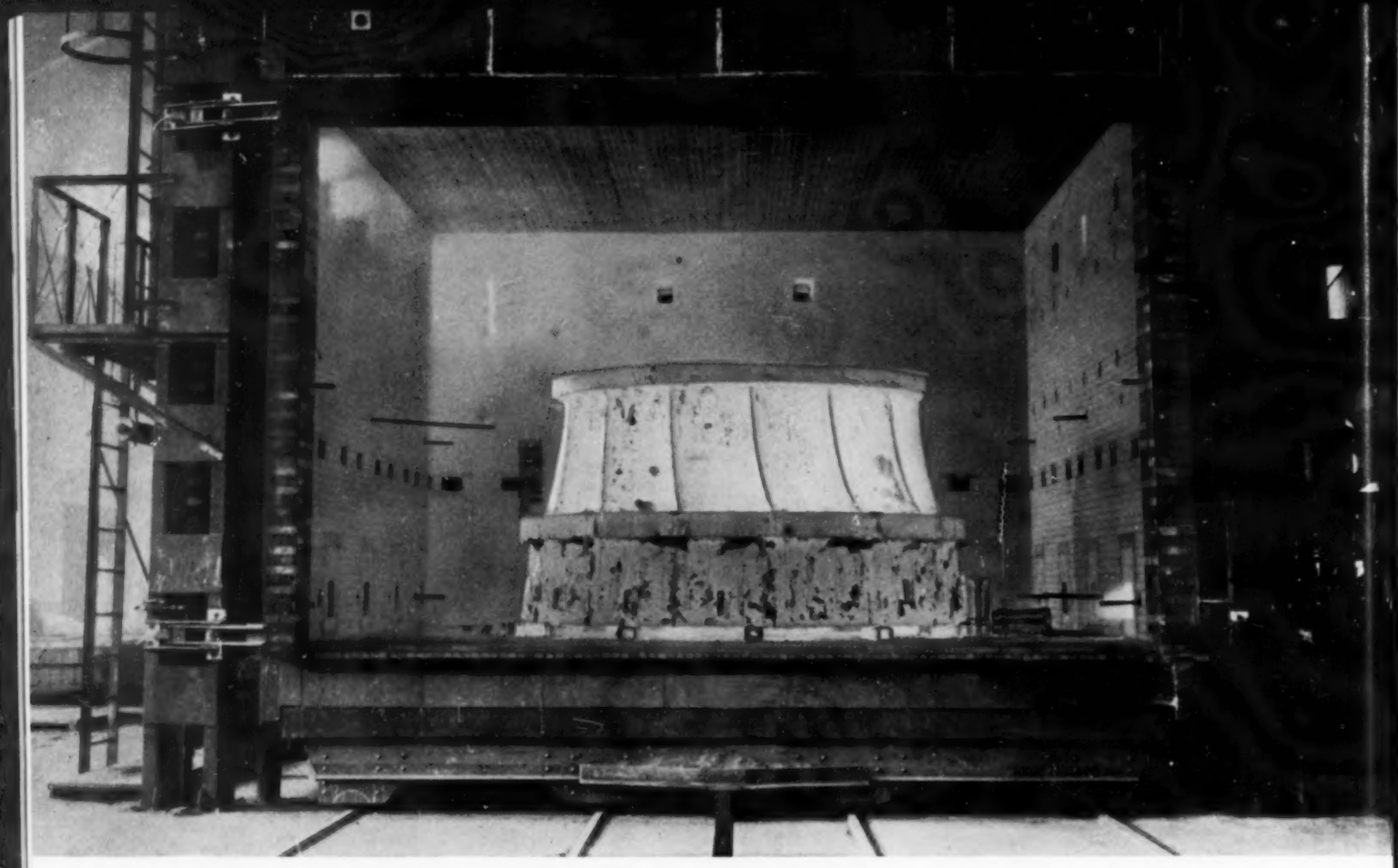




Completely Engineered. The Elliott Industry Engineering Department engineers complete mill drives and coordinates all equipment. Elliott furnishes the complete installation . . . including the rotating electrical equipment, control, switchgear, ventilating equipment, and installation drawings. Call your nearby Elliott District Office for details or write Elliott Company, Ridgway Plant, Ridgway, Pa. Ask for Bulletin Q-23A "Elliott Equipment for the Steel Industry."

ELLIOTT Company

R7-33



For best performance and maximum economy

7 different specialized refractories used in annealing furnace lining

Engineering a furnace lining with *specialized* refractories can save dollars on construction, fuel and maintenance as well as extend productive working time. To achieve these results, seven different B&W refractories were used in the lining of this 25′ x 23′ x 14′ annealing furnace.

Fuel savings and close temperature control were made possible by using three types of *lightweight* B&W Insulating Firebrick. Walls are composed of *B&W K-23 IFB* backed up with *B&W K-16*. Because of the proximity of the burners, the roof was constructed of *B&W K-26 IFB*, a higher temperature brick to guard against the effect of possible localized overheating.

The weight saving construction means about 100 lb less refractory material to heat up per sq ft than with ordinary firebrick, or about 28 tons less in the roof of the furnace. Furthermore, supporting steel is less massive, far less costly. Commercial size steel can be used for roof suspension instead of special steels.

To eliminate the need for expensive special shapes, the burner tunnels are formed of *B&W's 3000 F refractory castable, Kaocast*. Lintels over the burners and jambs are constructed of rugged *B&W Junior Firebrick*.

To take advantage of fast, easily installed castable construction, *B&W Kaocrete-D* was used in the nose arch (separately pictured). This sturdy castable with a 2500 F use limit was selected to provide strong resistance to abrasion caused by door operation. In addition, the need for costly fired shapes and their supporting castings was eliminated, as was a great deal of expensive engineering detailing.

Nose arch, cast of B&W Kaocrete D, immediately after removing forms.

The car top is insulated with *B&W Kaolite-20*, a 2000 F insulating refractory concrete.

For further information, write for B&W bulletin R-2-H on insulating firebrick and B&W bulletin R-35 on castables.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

R-574

Publication Service...

DECEMBER, 1957

You Can Obtain . . .

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Worm Gear Speed Reducers

The Jones Machinery Division of Hewitt-Robins, Inc., has issued a new 40-page booklet on worm gear speed reducers. The booklet contains a description of various worm gear reducer designs with horsepower ranging from less than 0.1 to 121 as well as data and calculations for selection and application of these units. Numerous drawings and specification tables show designs and ratings for the many standard units available.

(2) Industrial Truck

A pair of brochures—one covering specifications and drawings; the other a pictorial descriptive bulletin—describing Automatic Transportation Co.'s "Elbolift," new concept of an electric fork lift truck, is now available. This industrial truck is now being built in 12,000 to 20,000 rated lifting capacities, and is the first of the company's MF series.

(3) Speed Variators

A new bulletin describes General Electric Co.'s new line of packaged direct-current adjustable speed drives available from 3 through 150 horsepower, 220, 440, 550 volts, 3-phase a-c 60 cycle. Included is a power unit data slide rule for calculating case dimensions, horsepower, speed range, power unit weight and motor frame size. The speed variators feature a static excitation system using silicon rectifiers for decreased maintenance, and a new amplistat regulator to accurately compensate for load changes.

(4) Instrument and Control Switches

Construction features of Allis-Chalmers instrument and control switches (Type 210) and their advantages are described in a new bulletin released by the company. Available as either maintained or spring return contact types, the switches are used in conjunction with circuit breakers, transformer tap changers, motor-operated rheostats and many other types of electrically controlled apparatus. The bulletin includes operating information, a description of the various components, dimensions of modern, heavy duty, removable handles, and dial face plates along with cover take-off dimensions (14B8112A).

(5) Spindle Coupling

A catalog covering their spindle couplings for rolling mills has just been published by the Ajax Flexible Coupling Co. Inc. This new catalog describes, in full detail, the development, production and application of their dihedral spindle couplings for roller drives. Cross-section drawings and dimensional data are given on the various sizes and types of spindle couplings (Catalog 64).

(6) Sling Chains

A concise yet comprehensive dissertation on the properties and capabilities of their registered sling chains is contained in a 4-page bulletin available from the American Chain Division, American Chain & Cable Co., Inc. Featured is a listing of the 7 main points to consider when ordering sling chains. Also of interest is a chart giving the working load limits of 2-leg chains fashioned of X-Weld 125 or Endweldur 125 Chain. (DH-101)

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IRON & STEEL ENGINEER
1010 EMPIRE BUILDING
PITTSBURGH 22, PA.

IRON & STEEL ENGINEER

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50	ALLIS-CHALMERS MANUFACTURING CO.	BULLETIN 12B8494	Mercury arc rectifiers
51	ALLIS CO., LOUIS, THE	BULLETIN 105	Electric motors
52	ASKANIA REGULATOR CO.	BULLETIN 33.1	Edge position controls
53	BABCOCK & WILCOX CO., THE	BULLETIN R-2-H	Insulating firebrick
		BULLETIN R-35	Castables
54	BLISS CO., E. W.	BULLETIN 40-B	Rolling mills
55	BROOKS OIL CO., THE	BULLETIN K-26	Fluid lubricant
56	BUFFALO FORGE CO.	BULLETIN F-102	Mill motor cooling fans
57	CHEMICAL CONSTRUCTION CORP.	BULLETIN M-103	Washers
58	DELAVAL STEAM TURBINE CO.	BULLETIN 0504	Centrifugal compressors
59	DIAMOND POWER SPECIALTY CORP.		Industrial wired television
60	ELECTRIC CONTROLLER & MFG. CO., THE	BULLETINS 8200 & 8820	Synchronous motor starters
61	ELECTRIC CONTROLLER & MFG. CO., THE	BULLETIN 8210	Contactors
62	ELECTRIC FURNACE CO., THE		1958 calender with special atmosphere chart
63	EUCLID ELECTRIC & MFG. CO., THE	BULLETIN 5005	Mill-type contactor
64	EXIDE INDUSTRIAL DIV., ELECTRIC STORAGE BATTERY CO.		Ironclad batteries
65	FURNACE ENGINEERS, INC.		Furnace equipment
66	GEAR GRINDING MACHINE CO., THE		Constant velocity joints
67	GENERAL ELECTRIC CO.	GEA-6706	Mill-duty master switches
68	HAGAN CHEMICALS & CONTROLS, INC.		Reprint of article, "Problems of a New Soaking Pit Installation"
69	HERR EQUIPMENT CORP., THE	BULLETIN 561	Processing and handling equipment
70	INDUSTRIAL GEAR MFG. CO.		Cut gear products, applications, and services
71	KOPPERS CO., INC.		Pickle liquor regeneration process
72	LECTROMELT FURNACE DIV., MCGRAW-EDISON CO.	CATALOG 9-B	Lectromelt furnaces
73	MCGREGOR-MICHIGAN CORP.		Steel plate fabrications
74	NORTH AMERICAN MFG. CO.	BULLETIN 1-001	Hydraulic controls
75	OHIO ELECTRIC MFG. CO., THE	BULLETIN 112	Magnets
76	PANNIER CORP.		Marking devices
77	PARKER HANNIFIN CORP.	CATALOGS 4310, 4320, 4433 & 4434	Straight-thread fittings & hose-lok fittings
78	POST-GLOVER ELECTRIC CO., THE	BULLETIN 500	Steel grid resistors
79	SHEFFIELD CORP., THE		Device to measure thickness
80	SIMMONS MACHINE TOOL CORP.		Engineered rebuilding of equipment
81	STEARNS MAGNETIC PRODUCTS	BULLETIN 35-CI	Lifting magnets
82	TRABON ENGINEERING CORP.	BULLETIN 578	Centralized lubricating systems
83	UNITED STATES GRAPHITE CO., THE	BULLETIN 11	Recarburizing of steel
84	UNITED STATES STEEL CORP., INDUSTRIAL CARS		Designed cars
85	WALDRON CORP., JOHN	CATALOG 57	Flexible couplings
86	WESTINGHOUSE ELECTRIC CORP.	BOOKLET B-6548	Self-adjusting magnetic brake
87	WILSON-SNYDER WORKS, OIL WELL SUPPLY DIV., UNITED STATES STEEL CORP.		Pumps for high-pressure descaling applications

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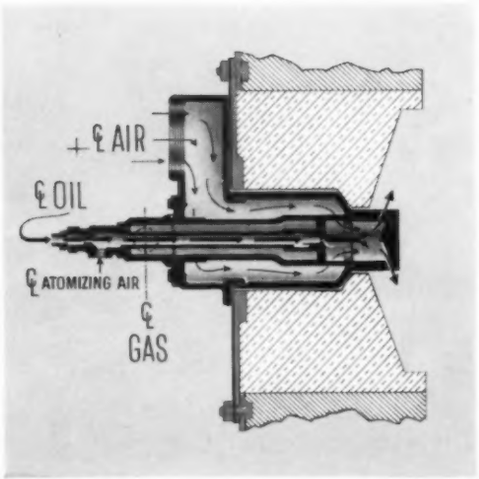
for intense concentration of heat . . .

The BLOOM HTR BURNER

The Bloom HTR Burner provides identical operation on either gas or oil.

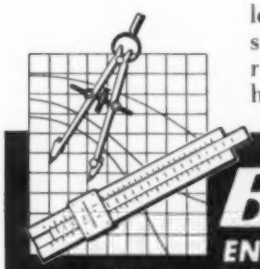


PATENT PENDING

This burner enables the engineer to design a heat pattern with excellent results, because it has the unique characteristic of providing localized high heat release with low forward velocity. The burner can be located to fire directly at the material without flame impingement. Roof firing is easily accomplished and provides uniform hearth temperature.

This burner has been very successful in its application to tube upset furnaces; continuous strip annealing, coating, and pre-heating lines; high speed billet heating furnaces; and batch-type forge furnaces.

The Bloom High Thermal Release Burner with its sturdy construction is ideal for applications requiring speed and precision heating.



BLOOM ENGINEERING CO., INC.

857 W. North Avenue Pittsburgh 33, Pa.

TRABON

CENTRALIZED LUBRICATING SYSTEMS

Trabon helps Cement Plants meet history-making production requirements for the Federal Road Program . . .

How can the Cement Industry increase production to meet the tremendous demands of the road program and still keep equipment operating efficiently? One answer is through TRABON CENTRALIZED LUBRICATING SYSTEMS.

Trabon automatically or manually delivers an exact amount of oil or grease to bearings, gears and sliding surfaces at the precise time necessary no matter where the location. Single indication of operation and the versatility of the Trabon Systems will help you maintain and increase your production, reduce downtime and wasted man hours as well as eliminating hazards in the lubrication of out-of-the-way bearings.

"Trabon In The Cement Industry" (Bulletin 578) is crammed with information every Production and Maintenance supervisor should know. Trabon's all new "Multizone" System for lubricating hundreds of bearings from one station is described. There are diagrams, sketches and application stories. Write for this free bulletin NOW!

Save money, increase production with Trabon Centralized Lubricating Systems. Send for this new booklet today!

Trabon

Trabon Engineering Corporation

28785 Aurora Road • Solon, Ohio

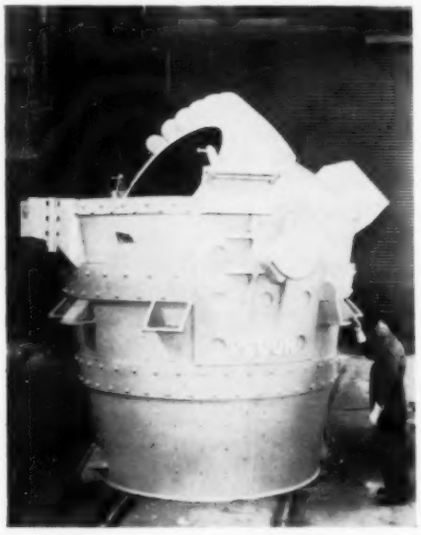
Centrakyl OIL AND GREASE SYSTEMS Metrylo CIRCULATING OIL SYSTEMS

Equipment News...

MIXING LADLES

▲ A new type high temperature metallurgical mixing ladle for a new plant for low-carbon chrome production has been designed and fabricated by Pennsylvania Engineering Corp., to include a number of attachments not usually seen on a steel ladle.

Like a cocktail shaker in appearance and use, the 200 cu ft (inside



refractory lining) capacity ladle handles material with a temperature range to 3200 F, and is designed for more efficient operation and handling.

As illustrated, a slagging spout is on the left, and a square, boxed-in pouring spout on the right. The feet around the center sides and the heart shaped block on the lifting trunnions provide locked, located support in the transfer and mixing equipment. A removable section of hood, not shown, closes the top of the ladle completely while in transit to prevent loss of heat. This removable section has openings for burners if needed. Two tilting lugs on the bottom sides are used to tip the ladle in either direction. The "U" shaped swinging brackets at the top edge lock the ladle to the carrying hooks to prevent tipping.

HOIST MOTOR CONTROL

▲ A new, simplified, smooth, accurate control for alternating current hoist motors, utilizing full magnetic control combined with an eddy current brake, has been announced by Northern Engineering Works.

Designed to be easier to operate and to maintain, this new control arrangement permits easier, safer and more accurate handling of loads. With excellent speed characteristics in both hoisting and lowering, smooth handling and accurate spotting of loads is assured.

All control electrical components are standard throughout. Circuits are simple and readily understandable—no complicated electrical schemes—used with standard eddy current brake to eliminate mechanical and electrical wear.

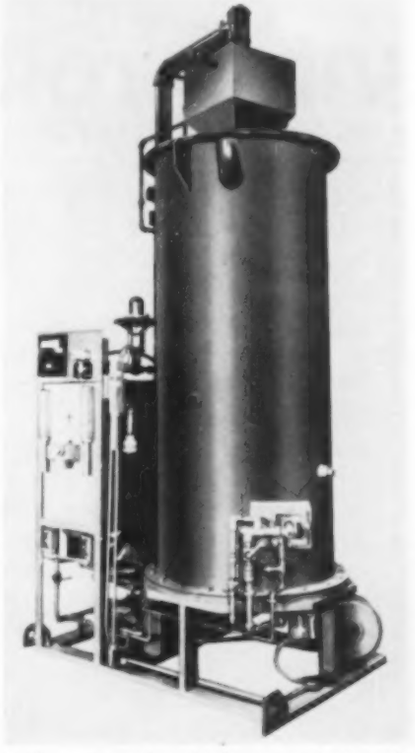
Excitation of the eddy current brake is automatically controlled by the motor speed, allowing extra smooth acceleration. For fast acceleration, the master switch may be moved to the last point, thereby eliminating the eddy current brake excitation. Off-point braking is provided automatically to assist the motor brake in stopping the load. The motor brake is automatically applied in lowering if the eddy current brake excitation should be interrupted. Speed curves can be readily changed in the field, either up or down, by a simple adjustment. When very heavy loads are handled, extra lowering speeds are automatically provided.

GAS GENERATORS

▲ A new line of endothermic gas generators for the production of gases used for maintaining equilibrium conditions during heat treating of metals has been announced by the A. A. Straub Co., Inc. The new equipment is designed to produce a blanketing gas, high in carbon-monoxide and hydrogen to provide a non-decarburizing atmosphere. Provisions for the addition of hydrocarbons used for carburizing processes can also be supplied.

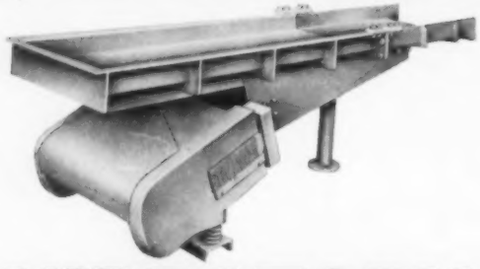
The generators are built in capacities from 200 to 5000 cfhr. The new line is of the space saving type with the combustion chamber placed in the vertical position to cut down on floor area requirements. Typical of the line is the 1500 cfhr model which occupies only 22 sq ft of floor space. All models are equipped with safety and control accessories and once lighted off, are equipped to operate automatically with nothing more periodic inspection required.

The air-fuel ratio is closely controlled through use of a special precision combustion-carburetor device which accurately mixes fuel gas and air in any selected ratio, thus permitting close control of the composition of the gas produced. Hazardous operation of the unit is prevented through the use of a safety shutoff valve which closes the fuel supply and shuts down the blower if a dangerous situation should develop. This safety valve is interlocked with a low fuel pressure switch, fire check and retort temperature con-



trol, any of which can instantly shut down the unit should trouble develop.

Fuels such as natural gas, propane, butane, or coke oven gas are mixed with air and reacted in an externally heated catalyst-filled retort. The product gas is then quickly cooled to prevent reaction reversal and piped directly to the process.



SYNTRON Vibratory Feeder feeding metal parts to continuous heat treating furnace.

SYNTRON
"Vibra-Flow"

VIBRATORY FEEDERS

SYNTRON "Vibra-Flow" Vibratory Feeders with variable control of materials flow will match the capacity of continuous operating equipment. The flow rate of SYNTRON Vibratory Feeders is instantly adjustable from minimum to maximum to meet production schedules.

SYNTRON Vibratory Feeders are applicable to most any materials handling problem. They provide a smooth even flow of sand, slag, ore, scrap, and finished products to conveyor belts, plating baskets heat treating furnace and other types of equipment.

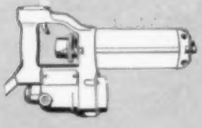
Increase production and lower operation costs by including SYNTRON Vibratory Feeders in your operation. Send us details of your materials handling problem. Our application engineers will be glad to make recommendations.

Available in Electromagnetic, Pneumatic or Hydraulic powered units.

Other SYNTRON Equipment of proven Dependable Quality

BATTERY CHARGERS

ELECTRIC HAMMERS



LAPPING MACHINES

Write for complete catalog data — FREE

SYNTRON COMPANY
699 Lexington Avenue Homer City, Penna.

TONGS

Two sizes of non-automatic tongs for lifting rounds and odd shapes have been added to the stock items manufactured by Heppenstall Co. They are intended for applications where there is a limited amount of lifting and inexpensive tongs are adequate. A link at one side holds the jaws open when the tongs are being lowered for a lift. This link can be dropped out of position instantly by allowing a bit of slack in the line, whereupon the jaws close firmly on the round and lift it safely. The 750-lb capacity tongs have a maximum opening of 9¾ in., and will accommodate rounds from 2 in. to 9 in. in diam. The 1,000-lb capacity tongs have a maximum opening of 12¾ in., and will accommodate rounds from 4 in. to 12 in. in diam.

CIRCUIT BREAKER

▲ I-T-E Circuit Breaker Co. has combined its 600-amp "L" frame and 800-amp "M" frame circuit breakers and introduced a new heavy duty 800-amp "LM" frame with all of the design and construction features previously found in the "L" and "M" frame breakers.

This new frame breaker is approved by the Underwriters' Laboratories throughout its full continuous current range. From a mounting standpoint, it is interchangeable with either the "L" or "M" frame circuit breakers as previously used. "LM" circuit breakers are supplied with interchangeable trip units with continuous current ratings ranging from 125 amperes to 800 amperes. NEMA interrupting ratings are 50,000 amp 240 volts, 35,000 amps

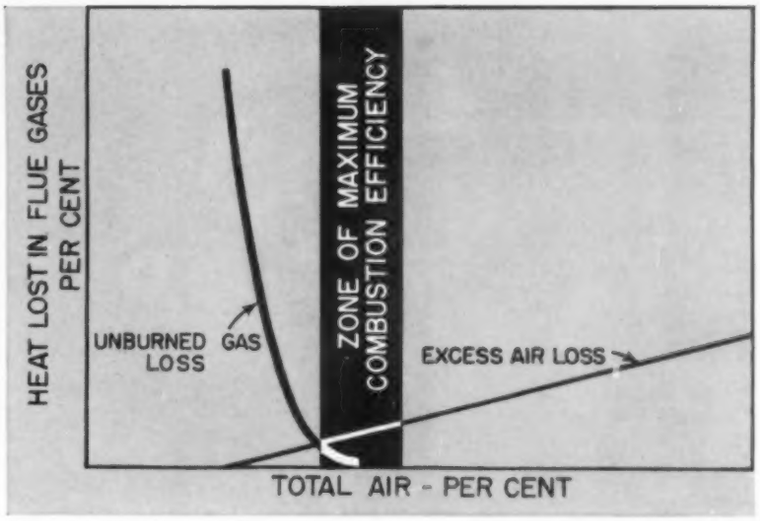
How to get maximum combustion efficiency . . . measure <u>both</u> combustibles and oxygen

Simultaneous measurement of both oxygen and combustibles is needed to obtain optimum combustion. No instrument that measures only one of these two interdependable factors can give you the full information necessary.

Now, Bailey offers two units, each giving a continuous and simultaneous double check on combustion efficiency: a permanent analyzer-recorder which records both factors on a single chart; and a new light weight, portable unit which indicates both factors.

Both instruments measure: (1) excess air—regardless of the fuel or combinations of fuel being burned, (2) mixing efficiency of your fuel burning equipment by showing per cent combustibles in the flue gas.

Both units are designed to increase efficiency in the furnace operations of the steel industry, on glass tanks, cement and lime kilns, ceramic and refractory kilns, steam boilers and also on direct and indirect-fired furnaces in the metal processing industries. To prevent your money from becoming waste gas, look into these two efficiency provers. A Bailey engineer will be glad to give you details or write us for product specifications.


HEAT LOST IN FLUE GASES PER CENT
UNBURNED GAS LOSS
ZONE OF MAXIMUM COMBUSTION EFFICIENCY
EXCESS AIR LOSS
TOTAL AIR - PER CENT

Maximum Combustion Efficiency is secured by keeping the sum of Excess Air Loss and Unburned Gas Loss to a minimum. To do so by the direct method simply measure both oxygen and combustibles in flue gas.

For portable use—
HEAT PROVER Analyzer

The famous Cities Service HEAT PROVER analyzer is now Bailey built and sold. Weighing only 25 pounds, it is a self-contained automatic analyzer including a sampling tip and hose plus a thermocouple for temperature measurement.

Instrument dials are dual range for greater accuracy and sensitivity.

For permanent installation
Oxygen-Combustibles Recorder

The Bailey Oxygen-Combustibles Analyzer-Recorder coordinates both records on one chart. These records enable the operator to keep fuel burning equipment performing continuously in the zone of maximum combustion efficiency. Excess air may be reduced to the point where combustibles begin to show.

G 40-1

Instruments and controls for power and process

BAILEY METER COMPANY

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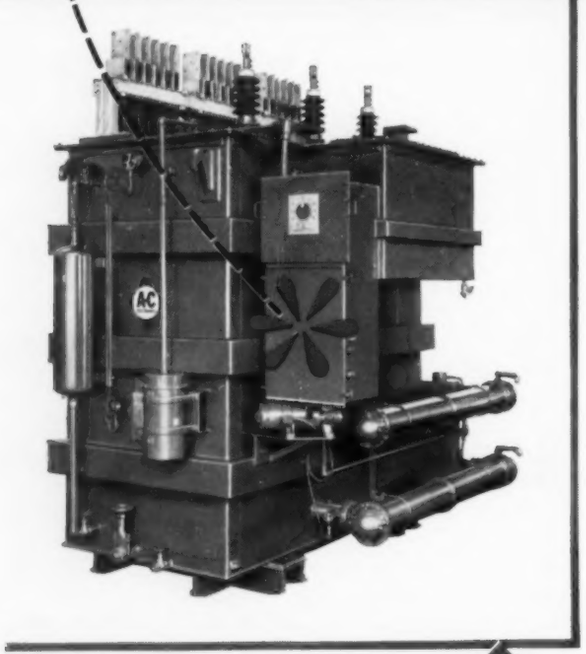
In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

Allis-Chalmers Furnace Transformers... in Step with Steel

Select Tap Sequence Quickly...Easily with

Selectoheat Control



With the new Allis-Chalmers furnace transformer you can arrange tap sequence at eye level as simply as 1-2-3. This remarkable convenience, made possible by *Selectoheat* control developed by A-C, slashes tap-changing downtime from hours to minutes.

Here's how it works — All primary taps are brought to a motor-operated tap changer in a separate compartment on the side of the tank. Positions on the tap-changer panels are connected to the *Selectoheat* control board. Here, a series of terminals are selected and closed to set up the required heat sequence for furnace operation. With the completion of tap sequence, tap positions are regulated in the conventional manner on the furnace operator's panel.

Other advantages are as follows: The under-oil terminal board is now eliminated . . . reducing transformer height. *Selectoheat* arrangement completes tap selection from the floor to halt top-of-transformer work hazards. Main tank need only be opened for periodic inspections.

Get all the facts. See your A-C representative or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

Selectoheat is an Allis-Chalmers trademark.

A-5528

ALLIS-CHALMERS

at 480 volts, 25,000 amps at 600 volts, all a-c; and 20,000 amps at 250 volts d-c.

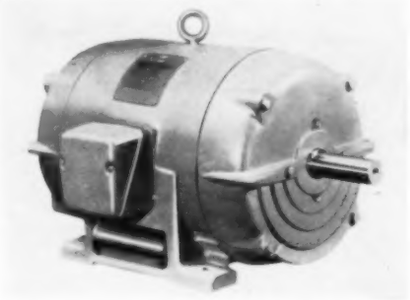
The "LM" may be used as panelboard main breakers, in power panels, switchboards, motor controls, bus duct plugs and individual enclosures. Pressure connectors are available for either single, double, or triple cable connections in each phase.

Special features such as shunt trips, auxiliary switches, alarm switches, and undervoltage trip devices can be furnished internally mounted.

INDUCTION MOTOR

▲ The Louis Allis Co. recently announced production of a synchronous induction motor built in the same NEMA frame size as a standard motor of equal horsepower.

Called the Syncro-Spede, this motor accelerates as an induction motor but runs at exact synchronous speed without permanent magnets or d-c excitation involving collector rings and brushes, wound rotating fields, etc. It is a compact a-c motor available for synchronous applications and offers high power factor and efficiency. It is suitable for



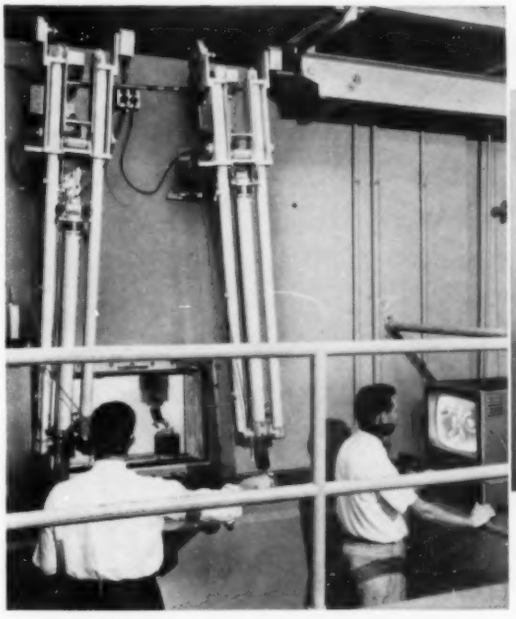
use on many applications requiring constant speed with varying load. Because of its size it can provide precise frequency systems in small generator ratings.

As a conveyor drive, the motor makes it possible to have an exact constant-speed or adjustable-speed system from no-load to full-load conditions with a minimum of driving units and controls. Since this motor is unaffected by voltage fluctuations, it is also ideal for precision timing and metering devices and for recording instruments.

The motor is manufactured in ratings from 1 to 100 hp in any enclosure type and can be foot or flange-mounted. It is designed for horizontal or vertical mounting with

Diamond "UtiliVue" (WIRED TELEVISION)

IMPROVES HANDLING of RADIOACTIVE MATERIAL



Mechanical manipulators are watched, close-up and from the side, by Diamond "UtiliVue". Personnel are fully protected from radiation.

Diamond "UtiliVue" camera mounted in radioactive cell has remote focus and three-position remote control lens turret.

AT NUCLEAR SYSTEMS
a division of the Budd Company
Philadelphia, Pa.

This is one of many installations where a Diamond "UtiliVue" permits close watch of operations with complete safety to personnel. The Diamond ITV Camera here is an invaluable ally to the viewing window as the mechanical manipulators handle radioactive material. It provides important depth perception and permits a close-up view for fine detail.

You may never handle radioactive material, but Diamond ITV can save you money and improve a wide variety of operations. Investigate today. Call your nearest Graybar Office or use the coupon below.

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DURALOY

A good example of our

WELDING TECHNIQUE

in connection with high alloy casting

SEND FOR YOUR COPY of our New General Bulletin.

This tube support is 21'6" long; 6'7" wide and weighs 8900 pounds. It looks like a single casting. Actually it is made up of three sections welded together in zig-zag strips across the face. It's a Duraloy HH casting destined for an oil refinery cracking still.

Welding is assuming greater and greater importance in the production of high alloy castings. Often it is the only way to produce large tonnage or unusually shaped pieces. During our many years of experience in producing both high alloy static and centrifugal castings, we have developed sound welding techniques for such castings. Carbon steel welding techniques won't serve. It takes special know-how for chrome-iron and chrome-nickel.

You can rest assured that if the chrome-iron or chrome-nickel castings you order from us require any welding, it will be done skillfully.

The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.

EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

a wide range of mechanical modifications available to meet specific application requirements.

BEARING SEAL

▲ The Timken Roller Bearing Co. has developed a roller bearing seal combining the features of the outside diameter seal and the face type seal. One lip operates in the bearing housing bore providing an outside diameter seal. The other lip operates against the smooth, flat, hardened and ground face of the bearing cup providing face type sealing.

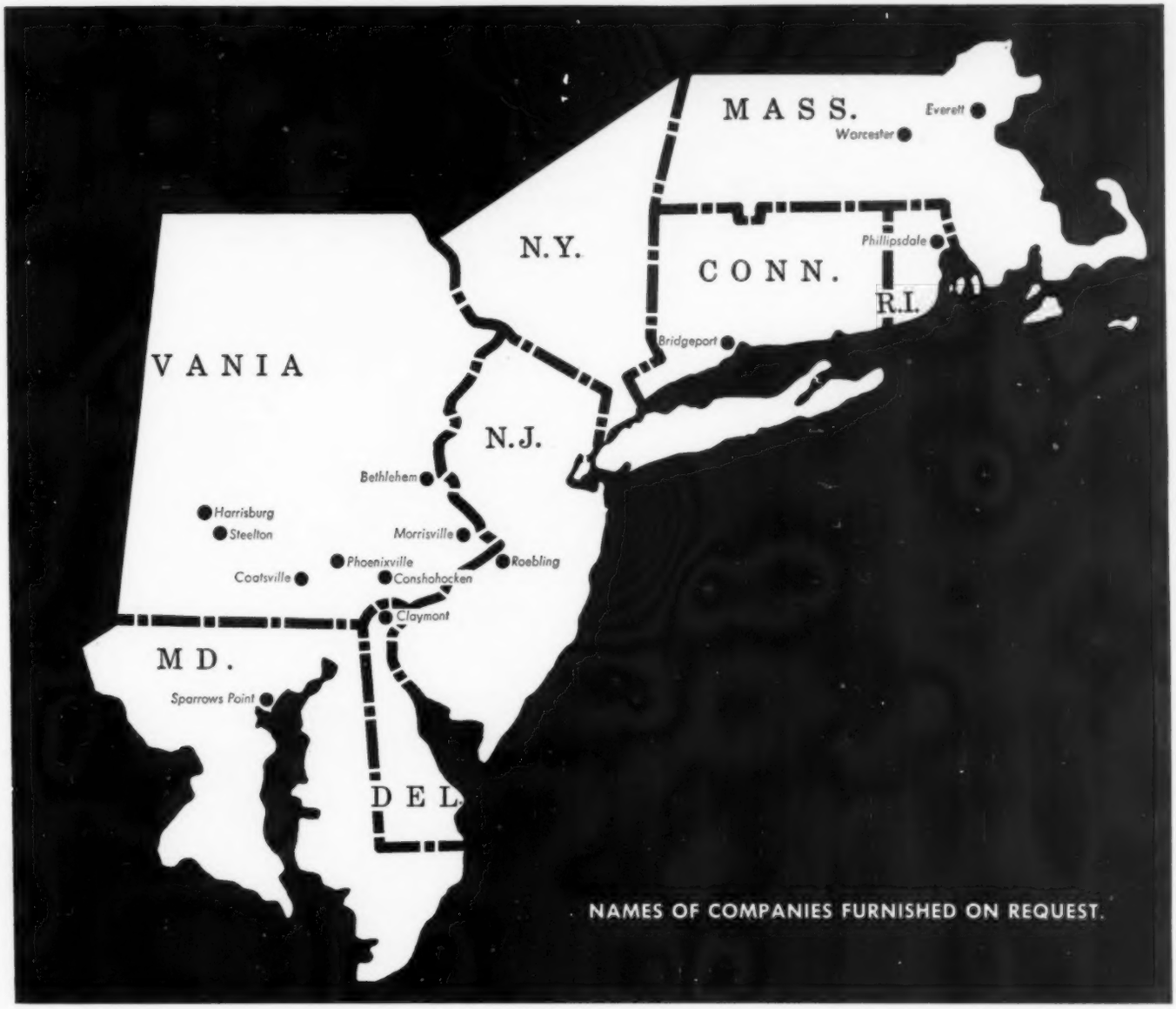
The synthetic "Duo-face" seal is supplied pressed onto the Timken bearing cone eliminating the handling and assembly problems related to conventional seals. No special tools and assembly fixtures are needed where close clearances exist with other machine parts. Since the seal adds very little width to the bearing, shorter hub and housing construction is possible.

Eliminated is polishing or turning of shafts and counter boring of seal seats with a corresponding savings resulting. Long bearing life is assured through a large initial supply of lubricant that can be easily replenished if required.

The seals are currently available on seven different sizes of bearings. These are by bore sizes: 0.750, 0.8437, 1.000, 1.250, 1.375, 1.500 and 2.6875 in.

SERIES "D" MOTORS

▲ A complete line of totally-protected, Series "D" a-c motors in the new, large NEMA Frame 364U through 445U is now being introduced by Reliance Electric and



Permanente #165 was chosen for 74 out of the last 90 rammed furnace bottoms installed in this area! Reasons: longer life, fewer repairs, less down time . . . advantages pioneered by—

For complete information,
ask for valuable installation manual "Permanente 165 and 84 Ramming Mixes for Open Hearth Furnaces."

Call or write Kaiser Chemicals Division, Dept. R-7461, Kaiser Aluminum & Chemical Sales, Inc., at any of the regional offices listed below:

PITTSBURGH 22, PA. . . . . 3 Gateway Center
HAMMOND, IND. . . . . 518 Calumet Building
OAKLAND 12, CALIF. . . . . 1924 Broadway

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PIONEERS IN MODERN BASIC REFRACTORIES

REFRACTORY BRICK AND RAMMING MATERIALS • CASTABLES & MORTARS
MAGNESITE • PERICLASE • DEADBURNED DOLOMITE • ALUMINAS

Photograph by courtesy of Brightside Foundry & Engineering Company Ltd.

ENGLISH ELECTRIC EQUIPS CONTINUOUS BAR MILL

This motor room for the 17 stand 11 inch continuous bar mill contains the stand drive motors totalling 8225 H.P., motor generator sets, booster sets and control gear.

The drives for the mill, flying shears, cooling beds and numerous auxiliaries, together with rectifiers and the control and distribution equipment for the high voltage and low voltage supplies, were engineered and supplied by English Electric.

If you are planning a complete steelworks electrification, or simply the addition for a small auxiliary drive, give us a call at any district office or write direct to our Metal Industries Division in St. Catharines or The English Electric Export and Trading Company Limited, Beaver Street, New York, N. Y. Our extensive experience is at your disposal.

'ENGLISH ELECTRIC' DIRECT CURRENT DRIVES

ENGLISH ELECTRIC COMPANY OF CANADA, LIMITED, ST. CATHARINES, ONT.
VANCOUVER, EDMONTON, CALGARY, WINNIPEG, TORONTO, OTTAWA, MONTREAL AND HALIFAX

PA-5773

Engineering Co. Foot-mounted and footless horizontal models in the 360 frame diameter are presently stocked in all standard enclosures—protected; totally-enclosed, fan-cooled; corrosion-proof; and explosion-proof—for operation on 208 through 550-volt in-plant alternating current. Other new NEMA frame sizes through 125 hp., with their modifications, are being made available on a monthly schedule.

In NEMA Electrical Design B, Design C and Design D, the new line of large-frame motors may be specified in many speeds with Class "A," Class "B" or high-temperature Class "H" insulation. Part-winding starting, to eliminate loading of power supply lines and resultant momentary light dimming, is available for commercial air-conditioning and other applications with similar requirements.

The new motors complement the present line of Reliance Totally-Protected Motors, which feature such items as Protected and Corrosion-Proof enclosures, exclusive "Metermatic" lubrication, an advanced insulation system, and a neoprene gasket to protect motor leads.

The protected enclosure, with a 40 C temperature rise, is designed for applications which formerly called for splash-proof motors. The corrosion-proof motor has all cast-iron construction, self-cleaning ribbed frame, corrosion-proof cast-iron fan, a shaft slinger to prevent the entry of foreign particles along the shaft, a watertight conduit box and hexhead bolts throughout for simple disassembly.

"Metermatic" lubrication gives a metered flow of lubricant to the bearings as needed to eliminate over-greasing or under-greasing. Automatic grease relief and elimination of lubricant "churning" decrease bearing strain, insuring longer bearing life. The advanced insulation system provides mylar slot cells, glass phase insulation, molded slot sticks, glass sleeving, polymerizing varnish, and acid-resistant, water-resistant red glyptol finishing enamel.

A neoprene gasket with enlarged pressure knobs "indexes" and firmly holds motor leads for protection and easy identification as they enter the conduit box. A stainless steel nameplate, impervious to damage, is standard on all totally-protected motors.

END CROPPING UNIT

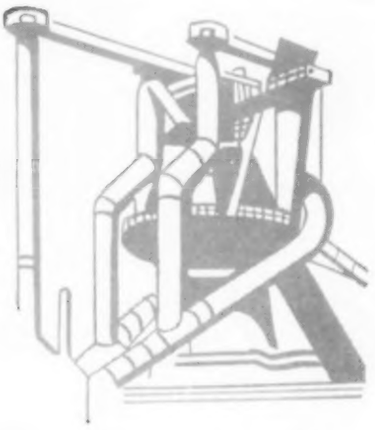
▲ A new hydraulic end cropping machine—recently installed in an automated resistance-weld steel pipe mill—is cutting 12-$\frac{3}{4}$in. od × $\frac{3}{8}$-in. wall steel pipe in 13 seconds. The machine is the model 1200 HC available from the Abbey Etna Machine Co.

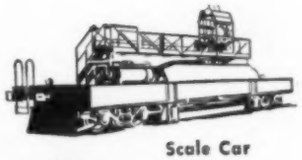
Head of the end cropper is stationary in this design application to crop sample pipe lengths for testing to API specifications. The workpiece remains stationary during the cutoff operation, while the cutoff tools rotate, a feature particularly advantageous in larger size pipe or tubing. Cutting speeds and feeds are not otherwise limited by the length, weight or straightness of a rotating pipe or tube.

Tooling setup consists of three turrets holding 12 carbide-tipped cutting tools. Three tools perform the actual cutting while the idle stations are for quick tool changes. Tools are fed by a hydraulic cyl-

(*Please turn to page 266*)

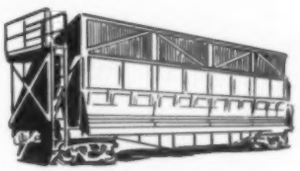
WHEREVER *performance* **COUNTS**





Scale Car

100-ton Ore Transfer Double Compartment, Bottom Dump



Coke Quenching Car

Atlas Cars are built to resist the high wear factors of continuous service handling abrasive materials. Extra factors of safety in brakes, controls, visibility, and signal devices are incorporated for foolproof service.

Each car is engineered to meet the operating needs of the plant where it will be used.

Consult Atlas for your Steel Plant Cars

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CAR & MFG. CO.
1100 IVANHOE ROAD
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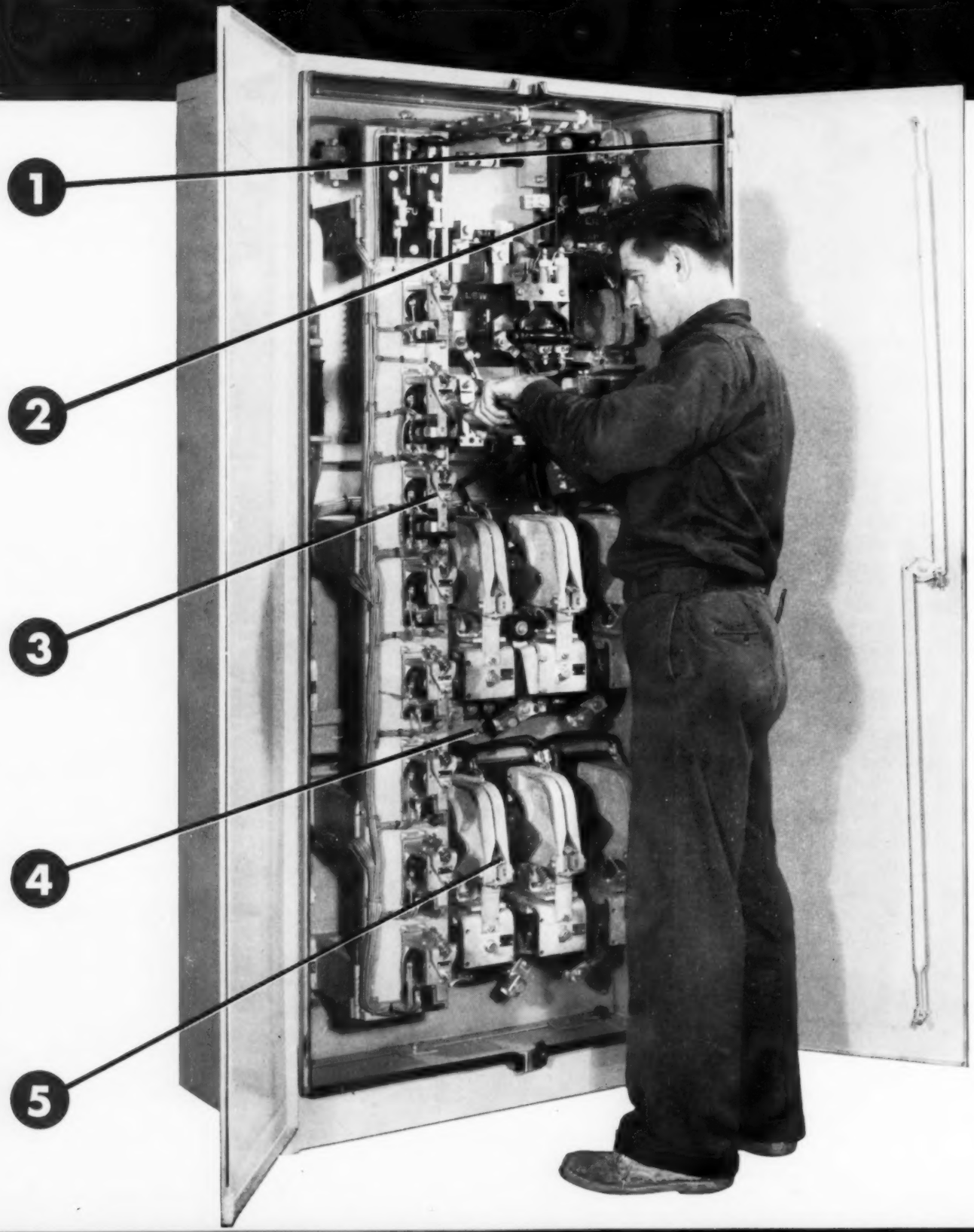
ENGINEERS AND MANUFACTURERS SINCE 1896

NEW



all front-connected d-c crane control from General Electric

SMALL SIZE AND ELIMINATION OF BACK AISLE CUT FLOOR SPACE REQUIREMENTS IN HALF!

General Electric announces the only completely front-connected d-c crane control panel on the market today! This new design feature eliminates any need for a back aisle. And here are five *more* reasons why General Electric is your best buy in d-c crane controls:

1. **Doors are quickly removed,** if desired, to provide ample room for installation and maintenance. The doors are hung on hinge pins to simplify removal. The lower pin is shorter than the top pin for ease of replacement.
2. **Devices are better protected** against shock and vibration by mounting on shock-resistant unit-bases. This construction also permits removal of devices as individual units from the front.
3. **Adjustable devices are readily accessible** because they are mounted on a hinged panel near the front of the enclosure. This panel swings open to provide access to a vertical wiring channel for the inter-connecting cables.
4. **Connections are made easy** by convenient terminals. Built-in wire troughs are formed by unit bases of individual devices.
5. **Spare parts are minimized** by use of rugged steel-mill devices, all of which use the same universal interlock for contacts on relays, and for auxiliary contacts on contactors.

Take advantage of this new space-saving design now. *Specify General Electric d-c crane controls!* Ask your General Electric sales engineer for information on the outstanding performance characteristics of General Electric d-c crane control. Or write for GEA-6434, to Section 785-3, General Electric Company, Schenectady, New York. Industry Control Department, Roanoke, Virginia.

UP TO 50 PERCENT LESS FLOOR SPACE is required by eliminating the back aisle and the use of a smaller panel enclosure.

Progress Is Our Most Important Product

GENERAL ELECTRIC

(*Continued from page 263*)

inder. Tool stroke is 1½ in. for 1¼-in. wall capacity pipe. Feeds and speeds are easily adjustable for any requirement by turning a dial on a hydraulic metering valve conveniently mounted. A similar arrangement also permits rapid tool traverse adjustments.

An hydraulically-operated tool steel collet grips the workpiece during the cutting operation. The collet is mounted in the spindle, which in turn is mounted on tapered roller bearings; the spindle is driven by a 25 hp d-c motor through v-belts.

Machine operation is by a separate floor-mounted hydraulic system. Valves and pumps are panel-mounted for quick maintenance; the valves are gasket-mounted, to remove without disconnecting any hydraulic lines.

The control panel pulpit not only contains start and stop controls for the machine, but in this case push-button-control for an entire assembly area in which the pipe is automatically conveyor-fed to the machine and electronically measured.

How to cut mill downtime due to bearing failures...

use A·B·K* bearings

Roll neck and slipper bearings made of A-B-K material often outwear metal bearings many times. Their ability to cushion impact loads without peening, scoring or heat-checking protects roller necks, housings and chucks. Simplicity of design and light weight speed installation. Can be lubricated with grease, oil or water *alone*. Ask our engineers to help you solve your specific problems.

- Wear longer
- Won't score or heat check
- Light in weight
- Cut lubricant costs
- Save power

A·B·K
LAMINATED PHENOLIC BEARINGS

*A registered trade-mark of American Brake Shoe Company in the United States and of Joseph Robb & Company, Limited, in Canada.

American Brake Shoe — American Brakeblok Division
DETROIT 9, MICHIGAN

Book Reviews

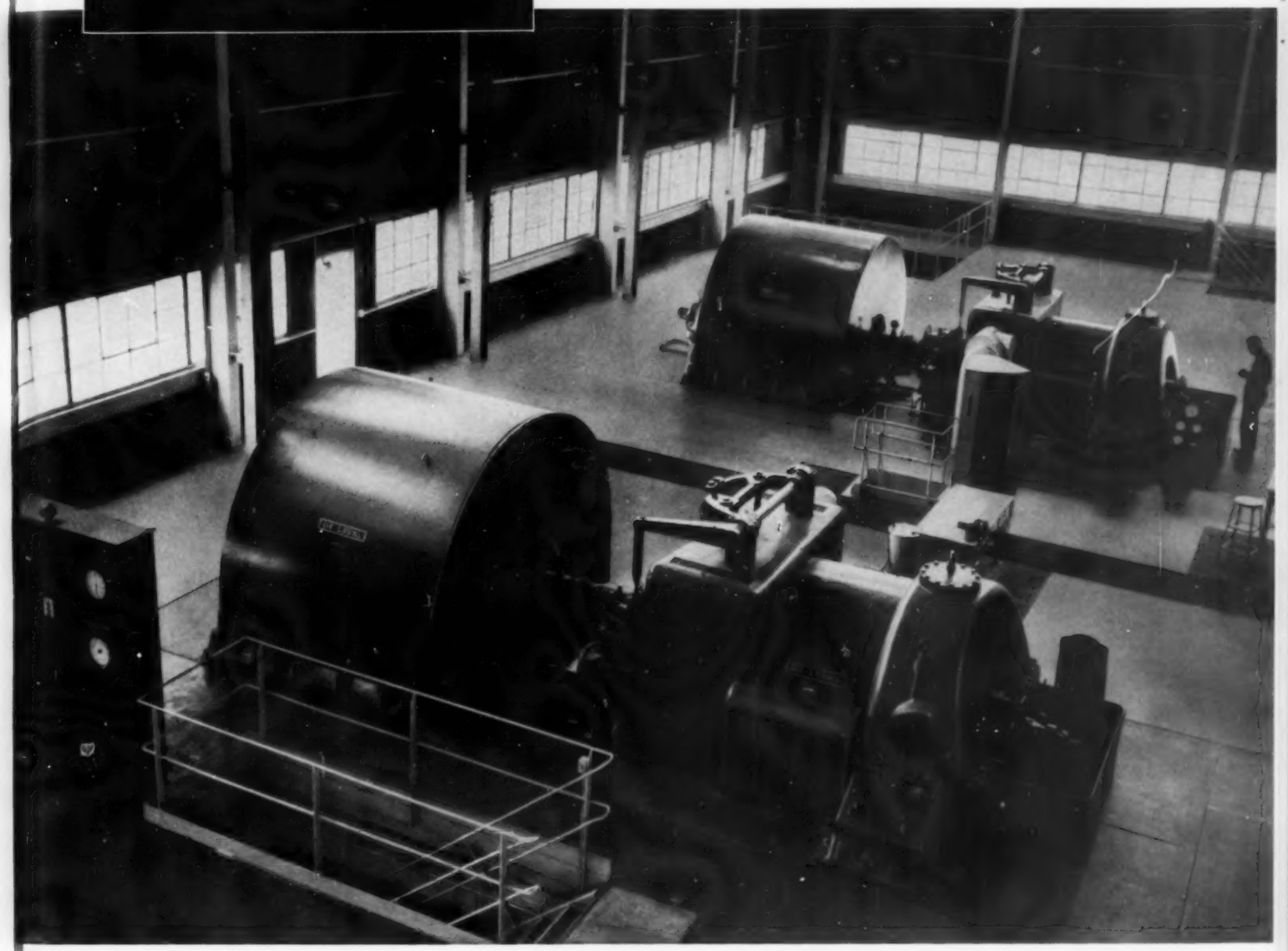
"The Manufacture of Iron and Steel, Volume One, Iron Production" second edition revised, by G. Reginald Bashforth, has recently been published by Chapman & Hall Ltd., 37 Essex Street, London, W.C. 2, England. The book contains 306 pages, 8½ × 5½ in., is cloth bound, and sells for 45s. net. This second edition, brought up to date in both information and illustrations, has clung to the original aim to provide a textbook for the student and a reference book for the industrialist. The text covers the subjects of iron ores and their occurrence, the blast furnace burden, preparation of iron ores; blast furnace fuels, reactions, and slags. Discussed also are principles of blast furnace design, blast furnace plant and equipment, refractories, operations, calculations, other methods of pig iron production, manufacture of ferro-alloys and special irons, blast furnace instruments, wrought iron. In addition to numerous illustrations to explain and emphasize the contents, there is also a bibliography, and a list of thermal details. The data in the book seems to be based primarily on British practice which seems to lag somewhat behind some of the latest American operations.

"Economics of American Industry" (third edition) by E. B. Alderfer and H. E. Michl has recently been published by the McGraw-Hill Book Co., 330 W. 42nd Street, New York 36, N. Y. The book contains 710 pages, 6 × 9 in., is cloth bound, and sells for $7.00. The purpose of this book is to present an introductory survey of the principal manufacturing industries in the United States. As a result of the economic changes in American manufacturing, the previous publications of this book are practically obsolete and the third edition, a complete revision, was made necessary. The book is divided into nine parts approaching the subject on an industry basis. Of particular interest is the section on steel which covers the place and structure of the iron and steel industry, the technology of iron and steel manufacture, location of the iron and steel industry, competition in the steel industry. There are

DE LAVAL

BLAST FURNACE BLOWERS

deliver 110,000 cfm each for McLouth Steel



These two De Laval turbine-driven centrifugal blowers do a round-the-clock job in the McLouth Steel plant, Trenton, Michigan. Each has a rated capacity of 110,000 cfm of air; discharge pressure is 30 psig. Each is driven by a 12,400 hp, 2950 rpm De Laval steam turbine operating under steam conditions of 600 psig, 825 F with 2″ hg.

De Laval compressors are designed individually for each application to assure maximum efficiency and range of operation. Construction is rugged throughout. Casings and perfectly balanced rotors are built to take punishment. All parts are precision-made to limit gages. Materials are selected which will best meet the particular conditions of corrosion, pressure and temperature.

De Laval centrifugal blowers are built in single and multi-stage types to supply air in volumes up to 150,000 cfm for all classes of service in steel, gas and coke plants. The wealth of application experience acquired by De Laval over the years assures a correct and economical solution to your blower problem.

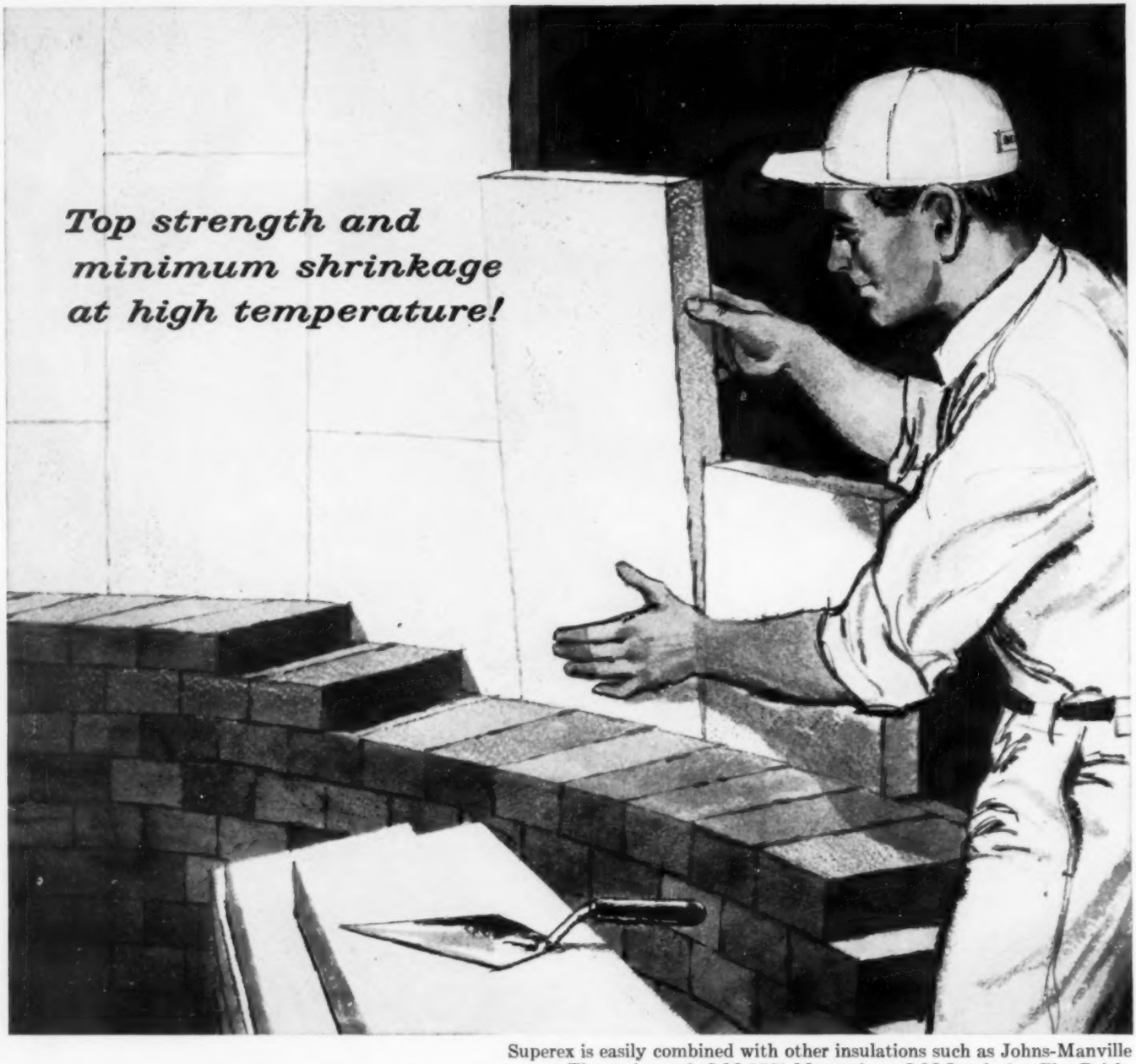
Send for Bulletin 0504

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY

870 Nottingham Way, Trenton 2, New Jersey

DL 360



Superex is easily combined with other insulations such as Johns-Manville Thermobestos®, J-M 85% Magnesia or J-M Insulating Fire Brick.

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there's still no substitute for J-M Superex insulation for service to 1900F!

In many ways, Superex® is the finest block insulation yet developed for high temperature furnace applications!

Made of diatomaceous silica and asbestos, Superex offers exceptional heat resistance—excellent insulating value. And at high temperature its stability is unsurpassed: it combines low shrinkage with excellent thermal effectiveness . . . easily withstands the physical abuse encountered in normal service.

Superex also speeds and simplifies installation. *Easy-to-handle*—Superex weighs only 2 lbs. per sq. ft. per inch thickness. *Strong*—it compresses only ⅛ inch under 6 tons' pressure per square ft. Superex is available in a wide variety of shapes and sizes . . . is easily cut with an ordinary knife or saw.

For further information write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

For medium temperature applications, specify J-M Superex M blocks . . . for temperatures to 1600F.

Saves waste. Superex comes in 7 standard thicknesses from 1" to 4". Other sizes available on order.

Johns-Manville INSULATIONS *FOR LASTING THERMAL EFFICIENCY*

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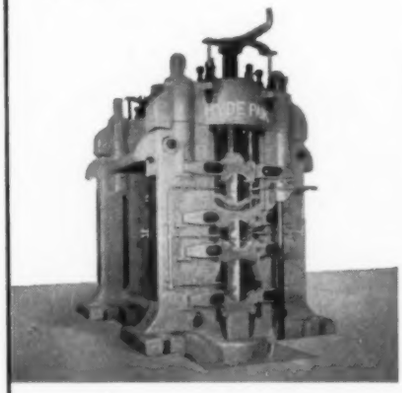
For more than 50 years Hyde Park Steel Mill equipment has been helping American industry lead the world—equipment such as—



Bar Mills
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For finer finish, long life and greater tonnage, specify Red Circle Rolls.

Hyde Park

FOUNDRY & MACHINE CO.

Hyde Park, Westmoreland Co., Pa.

ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

numerous illustrations throughout the text, practically all of which are new and up-to-date.

"Principles of the Properties of Materials" by Jacob Porter Frankel has recently been published by the McGraw-Hill Book Company, 330 W. 42nd Street, New York 36, N. Y. This book contains 228 pages, 6 × 9 in., is cloth bound, and sells for $6.00. A new approach on the subject is presented in this work with emphasis being placed on the principles and properties rather than materials. Each chapter opens with a synopsis in which the most important principles to be covered are stated, and the chapter is then devoted to an exposition of the logical derivations and use of these principles. A list of questions is contained at the end of each chapter. The book emphasizes the theoretical approach and starts with physics and atomic theory to develop the author's coverage of material properties.

"Strength of Materials" by F. R. Shanley, has recently been published by the McGraw-Hill Book Company, 330 W. 42nd Street, New York 36, N. Y. The book contains 783 pages, 6 × 9 in., is cloth bound, and sells for $8.50. The text contains material which forms the basis for all types of structural analysis and design. Examples and problems include practical cases from fields of civil, aeronautical, and mechanical engineering. The book is divided into three parts, each containing several chapters: Part One—Forces and Deflections, Stress and Strain; Part Two—Analysis of Structural Elements; and Part Three—Strength of Structural Elements. Numerous illustrations and problems are employed to complement the work. The book contains more information on structural design than usually found in strength of materials books and nicely ties the two subjects together.

"Basic Mathematics for Radio and Electronics" third edition by F. M. Colebrook and J. W. Head, has recently been published by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. The book contains 359 pages, 5 × 7 in., is cloth bound, and sells for $6.00. This work was previously published under the title "Basic Mathematics for Radio Students." The book deals with the basic

See how Simmons rebuilds your used machine tools of all types and sizes... inside out... and unconditionally guarantees original performance... at half the cost of a new machine!

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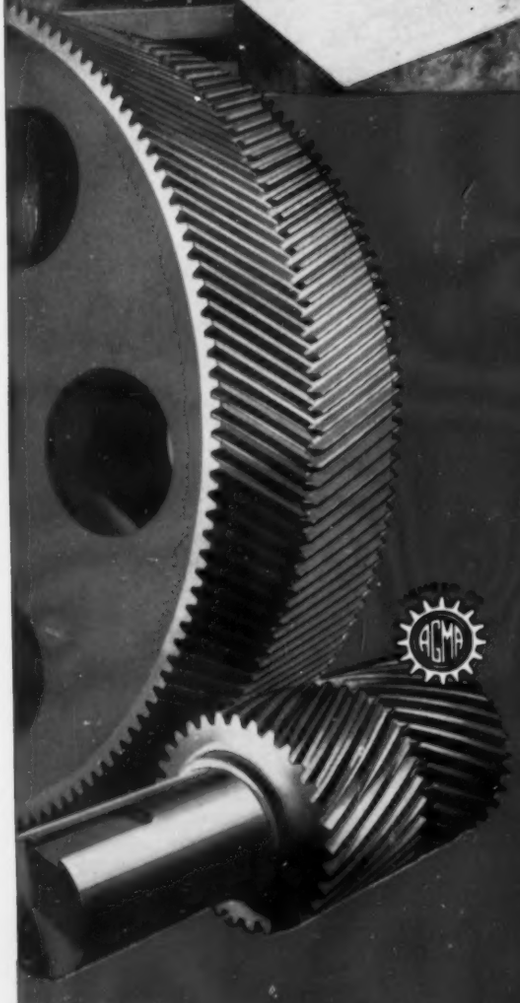
Herringbone generators at Industrial Gear that can—and do—"work the clock around".



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Massive production facilities are now in operation at IG to produce one or a thousand Herringbone cut gears . . . to meet your precise specifications always on time. This battery of Herringbone generators is part of the vast production potential at Industrial Gear where every type of cut gear is produced in its own specialized department by highly trained craftsmen. Further, every IG gear is assured always, all ways "Assembly Ready."

This is another reason why IG can become your dependable Gear Department regardless of the type and quantity of gears you need . . . when you need them.

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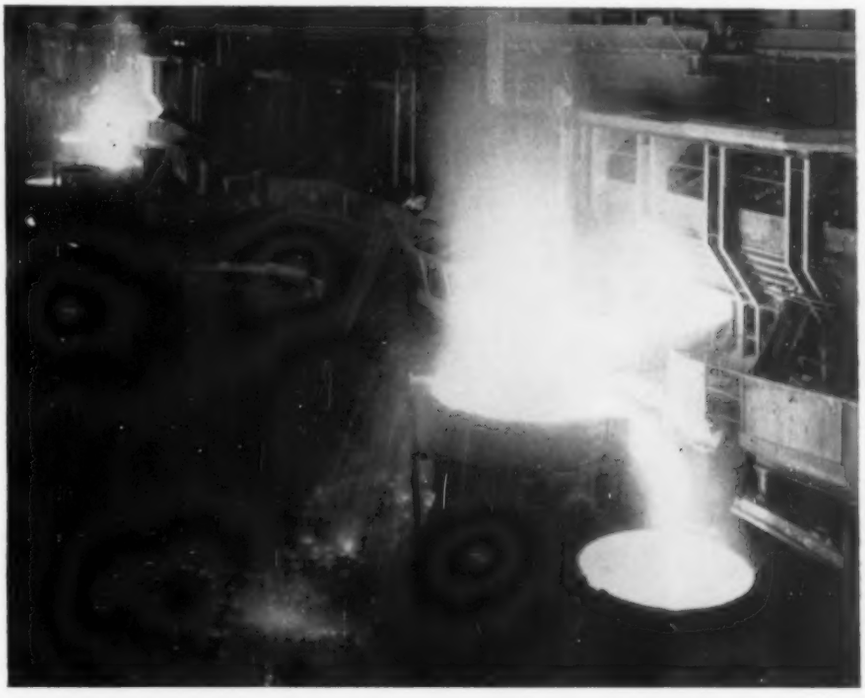
principles of those branches of mathematics which many years of practical experience in radio and electronics have shown to be definitely necessary or specially useful. The first seven chapters, starting with elementary algebra, lead up through indices and logarithms, series, limits, geometry trigonometry, vectors, and some calculus, to the basic electric circuits found in radio engineering. The last two chapters deal with more advanced branches of mathematics included because of the recent increasingly need for knowledge of such subjects as operations, or Heaviside, calculus, linear differential equations, matrices (with not more than two rows and columns), elementary statistics and numerical computations. One of the outstanding features of the book is its fundamental character, it lays a foundation in mathematics, and a gradual development is taken step-by-step, to endow the symbols with definite meaning, explaining the physical realities involved.

"Principles of Electrical Measurements," by H. Buckingham and E. M. Price has recently been published by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. The book contains 600 pages, 6 x 9 in., is cloth bound, and sells for $15.00. The chief aim of this book is to provide a knowledge of the principles employed in making electrical measurements and to explain the methods of applying these principles. The inclusion of valve methods, resonance and heterodyne measurements, and a fairly extensive treatment of the cathode ray oscillograph, recognizes a new approach to some long-established problems. Indicating instruments and deflectional methods are well established as an important part in measuring practices and a suitable proportion of the contents is devoted to these topics with sections on potentiometer and bridge methods, instrument transformers, integrating meters, measurements related to power systems, and the measurement of some non-electrical quantities. Numerous equations and line drawings are employed throughout the text which is presented in a style covering the requirements of the British Final Degree and A.M.I.E.E. examinations and of Higher National Certificate and Diploma courses. At the same time, the book is sufficiently comprehensive to serve as a reference source to those requiring information on electrical measurements.

"Mathematics for Science and Engineering," by Philip L. Alger (based on Engineering Mathematics by Charles P. Steinmetz) has recently been published by the McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. The book contains 360 pages, 6 x 9 in., is cloth bound, and sells for $6.95. This complete revision of "Engineering Mathematics" presents methods and procedures best adapted to solve a particular problem simply and quickly. It shows the unity and simplicity of the basic mathematical ideas. It reviews arithmetic, proceeds through algebra, trigonometry, calculus, probability, and linear differential equations, emphasizing complex numbers, infinite series, and methods of approximation. The text is arranged so that each subject comes as a natural extension of earlier topics, making for clarity and easy use of various mathematical methods or tools needed in performing different tasks.



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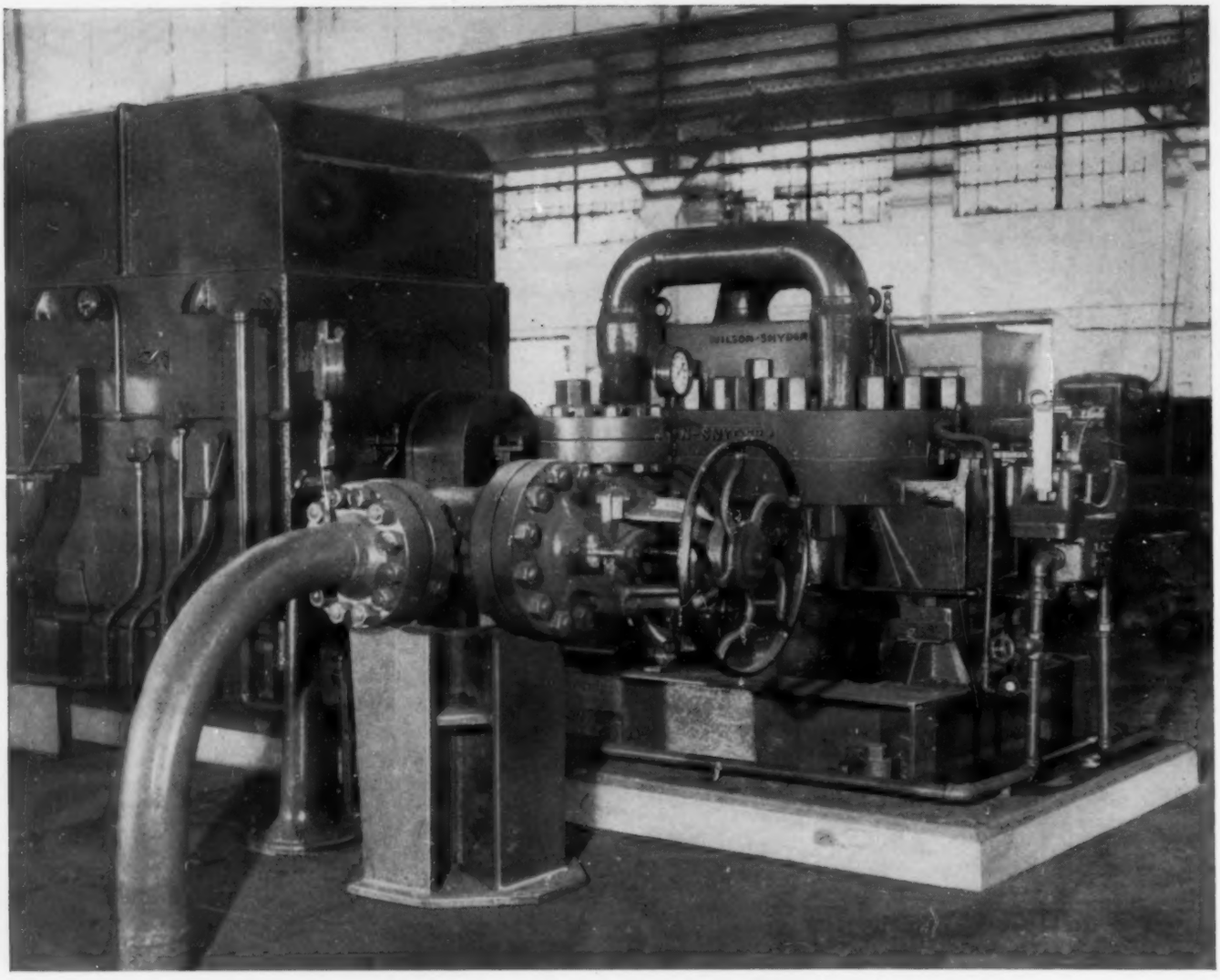

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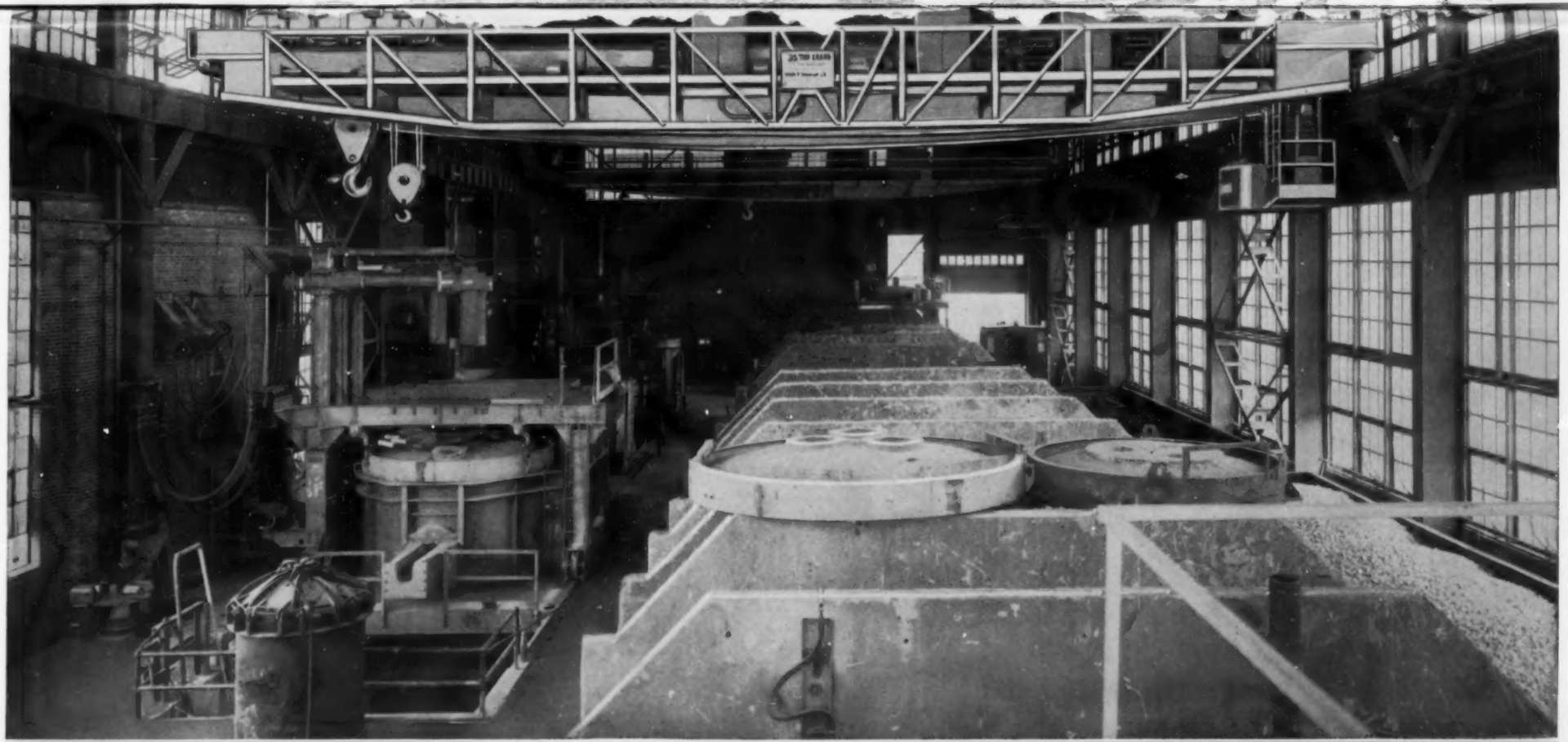

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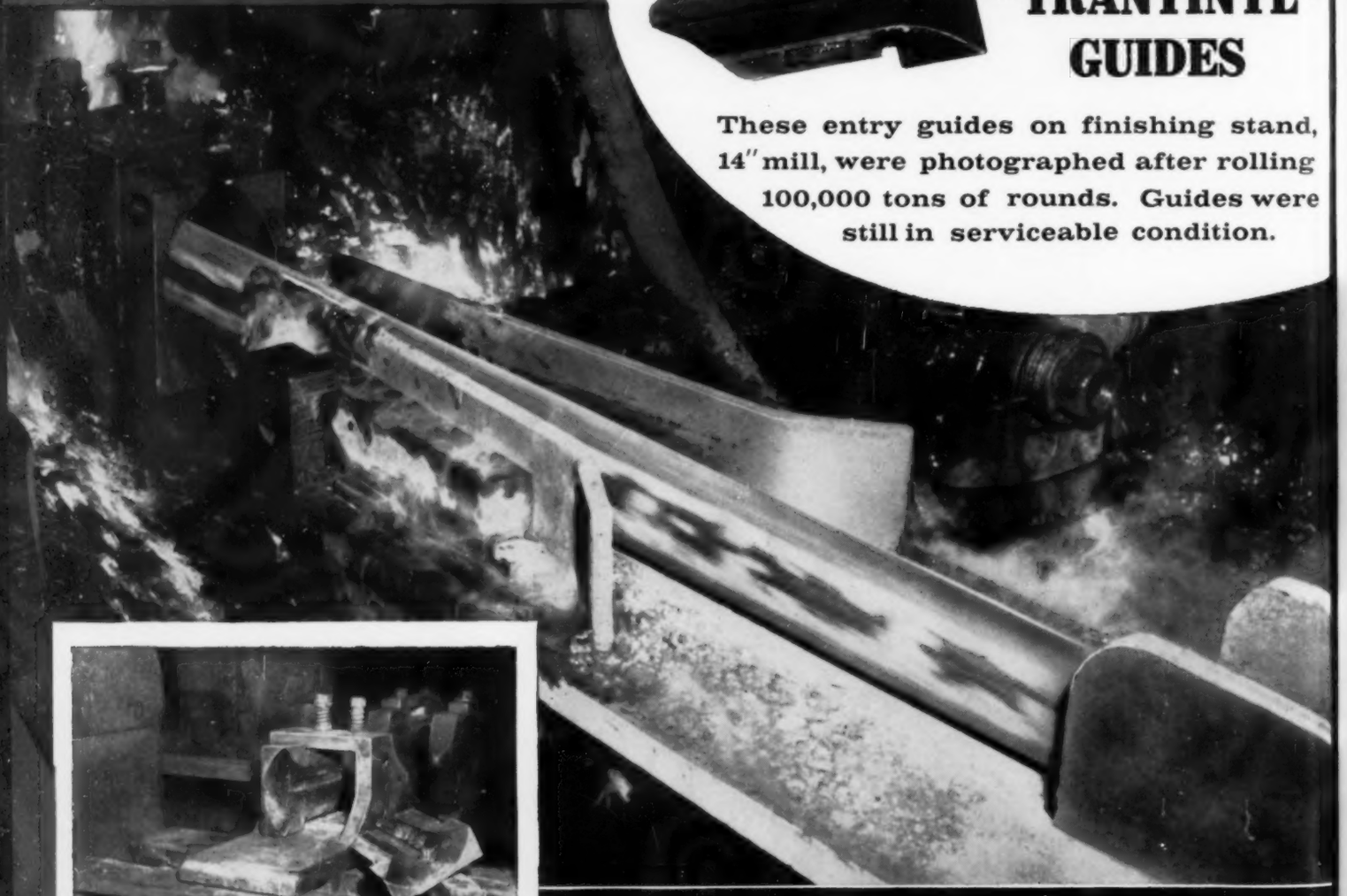

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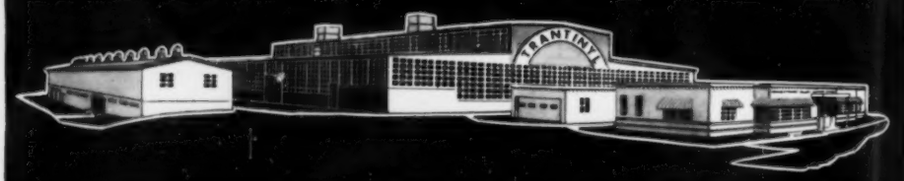

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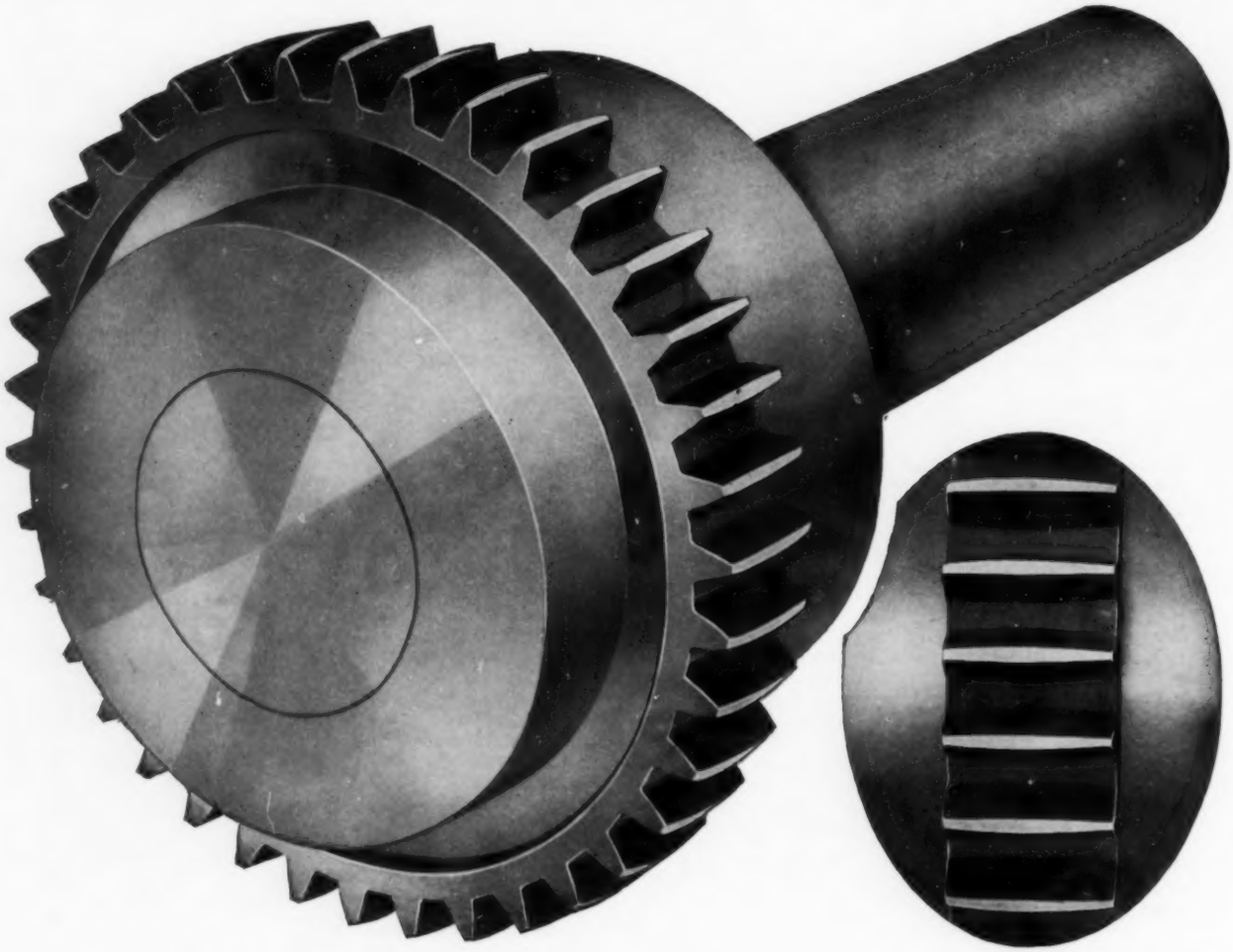

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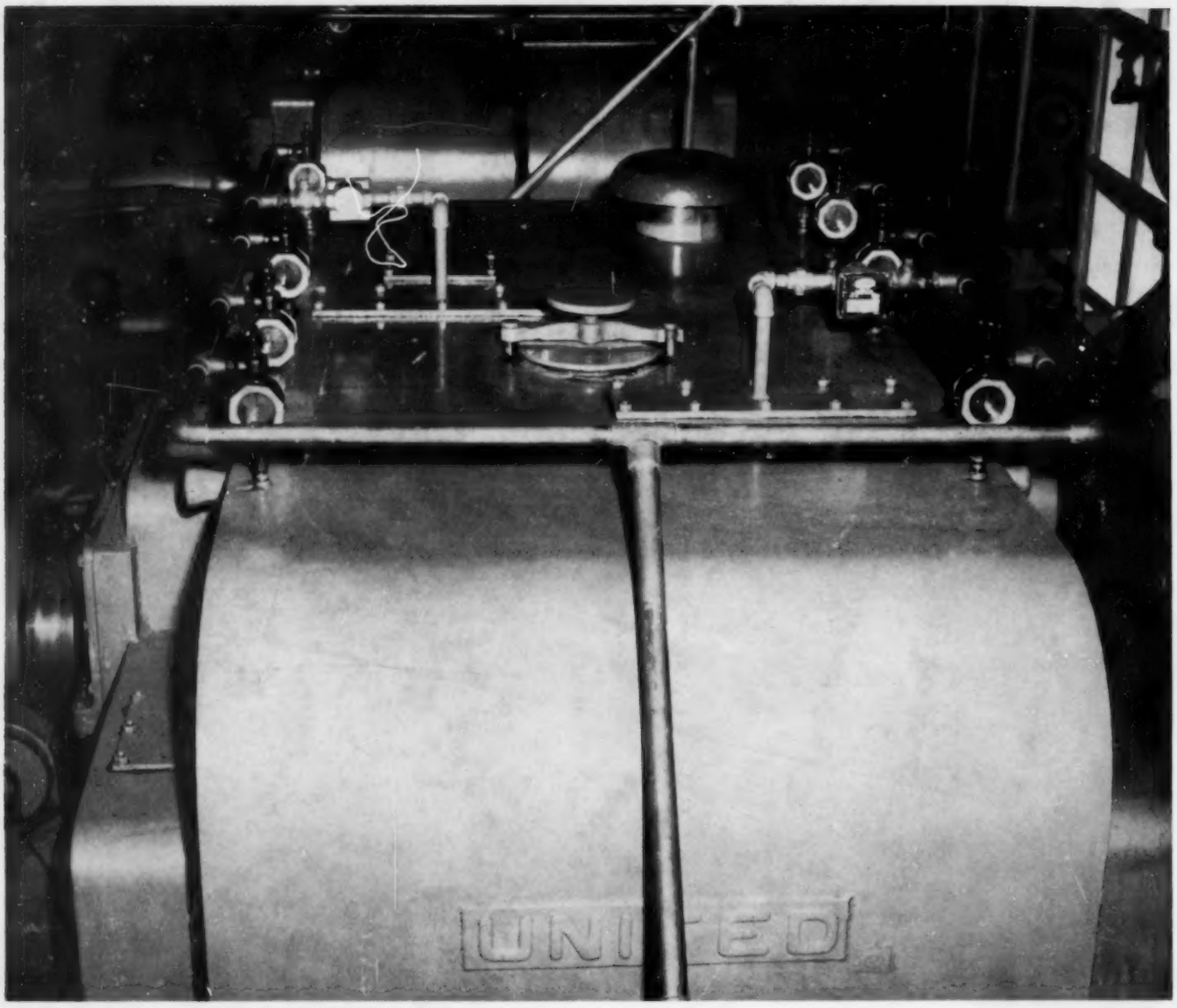

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